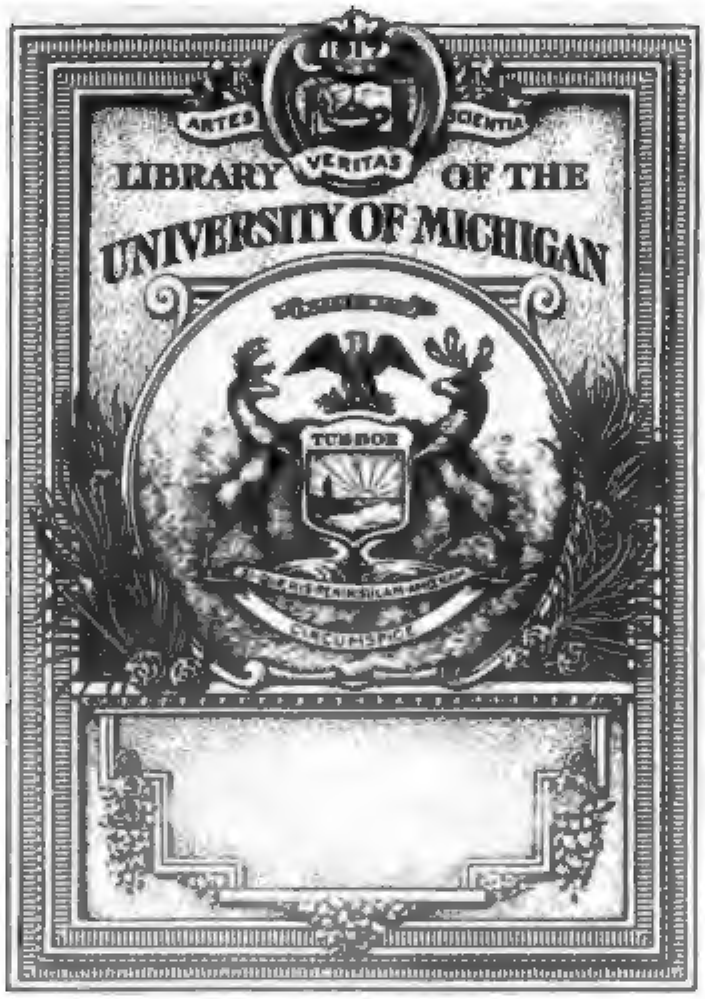

ARTES
VERITAS
SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
TUEBOR
CIRCUMSPICE

U. S. War Dept.

REPORT

OF THE

SECRETARY OF WAR;

BEING PART OF

THE MESSAGE AND DOCUMENTS

COMMUNICATED TO THE

TWO HOUSES OF CONGRESS

AT THE

BEGINNING OF THE THIRD SESSION OF THE FIFTY-THIRD CONGRESS.

VOLUME II—IN SIX PARTS.

PART 6.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1894.

9-13-1932

CONTENTS

[Alphabetical index will be found at the end of each part.]

PART I.

OFFICERS OF THE CORPS OF ENGINEERS.

FORTIFICATIONS.

SEA WALLS AND EMBANKMENTS, NEW YORK HARBOR.

SEA WALL AT FORT McHENRY, BALTIMORE HARBOR, MD.

WATER SUPPLY AT FORT MONROE, VA.

THE BOARD OF ENGINEERS.

POST OF WILLETS POINT, NEW YORK.—U. S. ENGINEER SCHOOL.—BATTALION OF ENGINEERS.—ENGINEER DEPOT.

RIVER AND HARBOR IMPROVEMENTS.

ATLANTIC COAST AND GULF OF MEXICO.

IN THE CHARGE OF MAJ. C. W. RAYMOND, CORPS OF ENGINEERS—

IN THE CHARGE OF WILLIAM F. SMITH, UNITED STATES AGENT, MAJOR OF ENGINEERS, U. S. ARMY, RETIRED—

IN THE CHARGE OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS—

IN THE CHARGE OF MAJ. CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS—

IN THE CHARGE OF CAPT. EDWARD BURR, CORPS OF ENGINEERS—

IN THE CHARGE OF MAJ. W. S. STANTON, CORPS OF ENGINEERS—

IN THE CHARGE OF CAPT. FREDERIC V. ABBOT, CORPS OF ENGINEERS—

In the charge of Capt. Carl F. Palfrey, Corps of Engineers—

In the charge of Maj. Charles J. Allen, Corps of Engineers—

In the charge of Maj. A. Mackenzie, Corps of Engineers—

In the charge of Maj. W. A. Jones, Corps of Engineers—

In the charge of Capt. Harry F. Hodges, Corps of Engineers—

In the charge of Capt. John Biddle, Corps of Engineers—

In the charge of Capt. George W. Goethals, Corps of Engineers—

In the charge of Lieut. Col. Amos Stickney, Corps of Engineers—

In the charge of Capt. R. L. Hoxie, Corps of Engineers—

In the charge of Capt. James G. Warren, Corps of Engineers—

IN THE CHARGE OF COL. O. M. POE, CORPS OF ENGINEERS—

IN THE CHARGE OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS—

IN THE CHARGE OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS—

IN THE CHARGE OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS—

N THE CHARGE OF CAPT. SMITH S. LEACH, CORPS OF ENGINEERS—

PACIFIC COAST.

IN THE CHARGE OF COL. G. H. MENDELL, CORPS OF ENGINEERS—

IN THE CHARGE OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS—

IN THE CHARGE OF MAJ. W. H. HEUER, CORPS OF ENGINEERS—

IN THE CHARGE OF CAPT. THOMAS W. SYMONS, CORPS OF ENGINEERS—

FORTIFICATIONS, ETC.

APPENDIX No. 1.

REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

APPENDIX No. 2.

REPORT OF LIEUT. COL. G. L. GILLESPIE, CORPS OF ENGINEERS.

APPENDIX No. 3.

APPENDIX No. 4.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

APPENDIX No. 5.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

RIVERS AND HARBORS, ETC.

APPENDIX A.

REPORT OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS.

APPENDIX B.

REPORT OF LIEUT. COL. S. M. MANSFIELD, CORPS OF ENGINEERS.

APPENDIX C.

REPORT OF CAPT. W. H. BIXBY, CORPS OF ENGINEERS.

APPENDIX D.

REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

APPENDIX E.

REPORT OF LIEUT. COL. G. L. GILLESPIE, CORPS OF ENGINEERS.

APPENDIX F.

REPORT OF CAPT. THOS. L. CASEY, CORPS OF ENGINEERS.

PART II.

APPENDIX G.

REPORT OF MAJ. C. W. RAYMOND, CORPS OF ENGINEERS.

APPENDIX H.

REPORT OF WM. F. SMITH, UNITED STATES AGENT, MAJOR OF ENGINEERS, U. S. ARMY, RETIRED.

APPENDIX I.

REPORT OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

APPENDIX J.

REPORT OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

APPENDIX K.

REPORT OF CAPT. EDWARD BURR, CORPS OF ENGINEERS.

APPENDIX L.

REPORT OF MAJ. W. S. STANTON, CORPS OF ENGINEERS.

APPENDIX M.

REPORT OF CAPT. FREDERIC V. ABBOT, CORPS OF ENGINEERS.

APPENDIX N.

REPORT OF CAPT. O. M. CARTER, CORPS OF ENGINEERS.

APPENDIX O.

REPORT OF MAJ. T. H. HANDBURY, CORPS OF ENGINEERS.

APPENDIX P.

REPORT OF MAJ. F. A. MAHAN, CORPS OF ENGINEERS.

APPENDIX Q.

REPORT OF MAJ. A. N. DAMRELL, CORPS OF ENGINEERS.

PART III.

APPENDIX R.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

APPENDIX S.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

APPENDIX T.

REPORT OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS.

APPENDIX U.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS.

APPENDIX V.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

APPENDIX W.

REPORT OF CAPT. CARL F. PALFREY, CORPS OF ENGINEERS.

APPENDIX X.

REPORT OF MAJ. CHAS. J. ALLEN, CORPS OF ENGINEERS.

APPENDIX Y.

REPORT OF MAJ. ALEXANDER MACKENZIE, CORPS OF ENGINEERS.

APPENDIX Z.

REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS.

APPENDIX A A.

REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS.

APPENDIX B B.

REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS.

APPENDIX C C.

REPORT OF CAPT. GEO. W. GOETHALS, CORPS OF ENGINEERS.

APPENDIX D D.

REPORT OF LIEUT. COL. AMOS STICKNEY, CORPS OF ENGINEERS.

APPENDIX E E.

REPORT OF CAPT. R. L. HOXIE, CORPS OF ENGINEERS.

APPENDIX F F.

REPORT OF CAPT. J. G. WARREN, CORPS OF ENGINEERS.

APPENDIX G G.

REPORT OF COL. WM. P. CRAIGHILL, CORPS OF ENGINEERS.

APPENDIX H H.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

PART IV.

APPENDIX I I.

REPORT OF MAJ. CLINTON B. SEARS, CORPS OF ENGINEERS.

APPENDIX J J.

REPORT OF MAJ. JAMES F. GREGORY, CORPS OF ENGINEERS.

APPENDIX K K.

REPORT OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS.

APPENDIX L L.

REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS.

APPENDIX M M.

REPORT OF COL. O. M. POE, CORPS OF ENGINEERS.

APPENDIX N N.

REPORT OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS.

APPENDIX O O.

REPORT OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS.

APPENDIX P P.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

APPENDIX Q Q.

REPORT OF CAPT. SMITH S. LEACH, CORPS OF ENGINEERS.

APPENDIX R R.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

APPENDIX S S.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

APPENDIX T T.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

APPENDIX U U.

REPORT OF CAPT. THOMAS W. SYMONS, CORPS OF ENGINEERS.

APPENDIX V V.

REPORT OF MAJ. JAMES C. POST, CORPS OF ENGINEERS.

APPENDIX W W.

REPORT OF LIEUT. COMMANDER DANIEL DELEHANTY, UNITED STATES NAVY.

PART V.

APPENDIX X X.

REPORT OF THE MISSISSIPPI RIVER COMMISSION.

C. B. COMSTOCK, colonel, Corps of Engineers, bvt. brig. gen., U. S. A., president; CHARLES R. SUTER, lieutenant-colonel, Corps of Engineers, U. S. A.; AMOS STICKNEY, lieutenant-colonel, Corps of Engineers, U. S. A.; HENRY L. WHITING, assistant U. S. Coast and Geodetic Survey; B. M. HARROD, ROBERT S. TAYLOR, and HENRY FLAD, *commissioners.*

PART VI.

APPENDIX Y Y.

REPORT OF THE MISSOURI RIVER COMMISSION.

APPENDIX Z Z.

REPORT OF THE CALIFORNIA DÉBRIS COMMISSION.

APPENDIX A A A.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS.

APPENDIX B B B.

REPORT OF COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS.

APPENDIX C C C.

REPORT OF COL. JOHN M. WILSON, UNITED STATES ARMY.

APPENDIX D D D.

SURVEY OF NORTHERN AND NORTHWESTERN LAKES.

APPENDIX E E E.

REPORT OF MAJ. WILLIAM A. JONES, CORPS OF ENGINEERS.

APPENDIX F F F.

EXPLORATIONS AND SURVEYS IN MILITARY DEPARTMENTS.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIX Y Y.

ANNUAL REPORT OF THE MISSOURI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1894.

SIR: The Missouri River Commission beg leave to submit herewith their annual report for the fiscal year ending June 30, 1894.

SURVEYS AND EXAMINATIONS.

During the past year work has been pushed as rapidly as possible on the preparation and publication of a complete set of maps of the Missouri River from its mouth to its headwaters. These maps, which embody not only the results of surveys made by the Commission, but also of all others which are considered reliable, are well advanced, and it is expected that the whole set will be completed and published during the coming fiscal year.

A careful revision of the elevations of all bench marks of a permanent character has been in progress and their connection with the line of precise levels has been completed. The tabulation of this work is not yet finished, but it is expected that the results will be made available during the coming year.

As a further check upon the secondary triangulation executed by the Commission, connection has been made with the primary triangulation of the U. S. Coast and Geodetic Survey near Kansas City, Mo. Connection with this system had already been made at St. Louis and near Jefferson City, Mo.

A monument giving geodetic position, elevation, and direction of meridian was placed in the capitol grounds at Jefferson City, Mo.

Twenty-one gauges were read throughout the year and two others during a portion of the same. Bulletins were established at all gauges at and below Kansas City to enable passing boats to ascertain the stage of water without landing. Those pertaining to gauges established on bridges are also designed to indicate the clear height under the superstructure available for the passage of boats.

In addition to the above work the reduction and study of physical data has been continued, as well as much work of a miscellaneous character.

For details see report of the secretary of the Commission (Appendix A).

CONSTRUCTION.

For details see appendixes B, C, D, E, and F.

Council Bluffs, Iowa.—The break in the revetment constructed near this place, and which was alluded to in the last annual report, was repaired during the late fall and early spring, 2,600 feet of bank being protected. No further damage has occurred at this point.

St. Joseph, Mo.—The damaged portion of the Belmont Bend revetment, described in our last report, was thoroughly repaired during October and November of 1893, 4,500 feet of revetment being constructed. A further slight break occurred recently, which could not be repaired owing to the high stage of water. Until this subsides the extent of the damage can not be definitely ascertained, but it is not thought to be serious.

Kansas City, Mo.—No work was done here during the past season, and the plant which had been used in the spring was sent to the Gasconade division. The harbor lines in front of Kansas City, Kans., and Kansas City, Mo., which had been recommended by the Commission were approved by the Secretary of War under date of December 9, 1893.

SYSTEMATIC IMPROVEMENT OF FIRST REACH.

The first reach, herein referred to, extends from the mouth of the Osage River to the mouth of the Missouri. For convenience of work and administration it is now divided in two parts, the Osage and Gasconade divisions, which, respectively, cover work in the vicinity of the mouths of those two streams.

The Osage division work extends to the head of Murrays Bend, 14 miles above the Osage. This extension was found necessary to get a secure heading for the work and to get the river in proper training before reaching the formidable bars at the mouth of the Osage. Murrays Bend is revetted. Below that point groups of permeable dikes have been put in wherever the necessity was apparent, the object being to keep the river along the rocky shore at and below Jefferson City, and in a concentrated channel of suitable width as far as the mouth of the Osage. From this point it is to be led on as nearly a straight line as possible through the wide shoals outside of Dodds Island, touching the detached bluff of Cote Sans Dessein, and reaching the right-hand bluffs again near Isbell Station. During the season work was carried on over a distance of about 20 miles, at all points and in such measure as the conditions warranted. The revetment of Murrays Bend, begun the previous season, was completed to the foot of the bend, a distance of 6,867 feet. Of permeable dike work, 10,472 feet was constructed, involving the driving of 3,426 piles. To prevent the escape of water into Osage Chute at low stages, a dam of brush and stone was built across the head of it. The dam proper is 1,525 feet long, and its crest is 2 feet above standard low water; with its shore connections it is 2,425 feet long. It was built late in the fall, and its immediate effect was to deepen the channel at the head of Dodds Island some 2 feet.

The development of the desired channel through these shoals is progressing rapidly and surely, though several seasons will probably be required to get the full effects. It is not possible at present to complete all the dikes required for this rectification for fear of obstructing the present boat channel, but such work as is possible must be done every year till the system is complete. Better or rather more rapid results might have been secured if higher stages of water had prevailed, but for the last two seasons only very moderate floods have been experienced. With the greater scour incident to greater volumes of water it is probable that the Osage Bar would have been entirely removed by this time. In anticipation of this result work has already been begun below Dodds Island, and as fast as funds enable the work to progress it will be extended downstream till it connects with the work of the Gasconade division, probably near the town of Chamois.

Work on the Gasconade division had been at the date of last report confined to preparation for active operations. August 16 dike work was commenced at Little Tavern Creek, a few miles below Portland, Mo. The work, essentially similar to that on the Osage division, was designed to control and rectify the river channel from Portland to the mouth of the Gasconade. During the season 10,175 feet of permeable dike was constructed, 3,200 piles being driven to an average penetration of 21 feet. In addition several large rocks obstructing navigation were blasted out and removed.

It is too soon to judge of results at this point, but so far the indications are very favorable.

Further operations in this division include the extension of the rectification upstream to Chamois and downstream to the Gasconade.

When this work and that of the first division is completed, 45 miles of river, from Murrays Bend to the Gasconade, will be fairly under control. As this portion embraces many points of very difficult navigation a fair test of the scope and value of the improvement will be afforded. The Commission hope to be able to do all the work needed for this purpose during the next two years, although probably several years must still elapse before full results are obtained.

In addition to the construction work here described a great deal of time and money has been devoted to the repair and reconstruction of the plant which had greatly deteriorated during the ten years which have elapsed since it was first built.

REMOVAL OF OBSTRUCTIONS.

The snag boat belonging to the Commission began work August 3 and was kept actively engaged till November 16. The river was cleared as far as Bushwhacker bend, 256 miles from the mouth, and a second trip was made as far as Barkersville, 142 miles from the mouth.

In the spring of 1894 the boat worked over the river again as far up as Kansas City. She is now laid up waiting for funds to enable her to resume this very important work.

Table of work done by snag boat.

Name of river.	Snags destroyed.		Trees cut.	Drift piles removed.	Miles run.
	Number.	Estimated weight in tons of 2,000 pounds.			
Ohio					100
Mississippi					510
Missouri	1,779	17,680.3	228	6	1,415
Total	1,779	17,680.3	228	6	2,025

As at the date of this report the appropriation bills for the current year have not been passed by Congress, no programme of work for the year is possible.

For the fiscal year ending June 30, 1896, the Commission beg leave to submit the following estimates:

For office and traveling expenses and salaries of Commission	$20,000
Surveys, gauges, physical data, and publications	30,000
Operating snag boat	35,000
Systematic improvement in first reach	665,000
Total	750,000

Money statement.

July 1, 1893, balance unexpended	$851,682.39
June 30, 1894, refunded during fiscal year on account of overpayment, etc.	164.86
Total	851,847.25
June 30, 1894, amount expended during the fiscal year	820,504.54
July 1, 1894, balance unexpended	31,342.71
July 1, 1894, outstanding liabilities	13,136.38
Amount available for fiscal year ending June 30, 1895	18,206.33
Amount that can be profitably expended in fiscal year ending June 30, 1896. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	750,000.00

Respectfully submitted.

CHAS. R. SUTER,
Lieut. Col. of Engineers.
President Missouri River Commission.
A. MACKENZIE,
Major of Engineers.
GARLAND C. BROADHEAD.
R. S. BERLIN.
CHAS. J. ALLEN,
Major, Corps of Engineers.

The SECRETARY OF WAR,
(Through the Chief of Engineers, U. S. A.)

Financial statement from July 1, 1893, to June 30, 1894.

Work.	Amount available July 1, 1893. Balances of appropriation, act of Sept. 19, 1890.	Balances of appropriation, act of July 13, 1892	Appropriation, act of Mar. 3, 1893.	Refunded on account of overpayment, etc.	Received by transfer from other allotments.	Total.	Amounts expended.	Transferred to other allotments.	Total expended and transferred, etc.	Total balances June 30, 1894.	Outstanding liabilities June 30, 1894.	Balances available June 30, 1894.
Improving Missouri River from mouth to Sioux City, Iowa.												
Construction, repair, and care of plant	....	$15,895.22	....	....	....	$15,895.22	$15,653.58	....	$15,653.58	$241.64	....	$241.64
Repair and maintenance of works in vicinity of Kansas City	$5,525.56	5,000.00	....	$7.22	....	10,532.78	10,532.76	....	10,532.76	.02	....	.02
Extending and completing revetment in vicinity of Council Bluffs, Iowa	182.98	....	....	....	....	182.98	182.98	....	182.98	....	....	....
Repair and completion of revetment in vicinity of Council Bluffs, Iowa	....	286.06	....	....	....	286.06	286.06	....	286.06	....	....	....
Repair of revetment in vicinity of Council Bluffs, Iowa	....	....	$15,000.00	....	$1,800.00	16,800.00	16,735.07	....	16,735.07	64.93	....	64.93
Repair of revetment in Belmont and Bon Ton bends	....	901.75	....	....	....	901.75	901.75	....	901.75	....	....	....
Repair of revetment in Belmont Bend	....	....	30,000.00	....	....	30,000.00	29,546.12	....	29,546.12	453.88	$31.65	422.23
Systematic improvement in First Reach	....	68,824.23	585,000.00	100.00	14,200.00	668,124.23	657,396.14	....	657,396.14	10,728.09	5,634.30	5,093.79
Operating snag boat	....	21,450.25	35,000.00	....	....	56,450.25	33,677.89	$16,000.00	49,677.89	6,772.36	2,247.06	4,525.30
Office and traveling expenses and salaries of Commission	....	4,137.54	20,000.00	....	....	24,137.54	20,904.88	....	20,904.88	3,232.66	1,714.76	1,517.90
Surveys, gauges, physical data, and publications	....	....	15,000.00	....	....	15,000.00	13,102.01	....	13,102.01	1,897.99	970.65	927.34
Surveys and observations	....	16,227.67	....	....	....	16,227.67	9,620.94	....	9,620.94	6,606.73	1,330.00	5,276.73
Gauges, physical data, and publications	....	13,251.13	....	5.50	....	13,256.63	11,964.36	....	11,964.36	1,292.27	1,155.82	136.45
Surveys and examinations	....	....	....	26.48	....	26.48	....	....	....	26.48	26.48	....
Surveys	....	....	....	25.66	....	25.66	....	....	....	25.66	25.66	....
Total	5,708.54	145,973.85	700,000.00	164.86	16,000.00	867,847.25	820,504.54	16,000.00	836,504.54	31,342.71	13,136.38	18,206.33

Detailed statement, July 5, 1884, to June 30, 1894.

Work.	Balances of appropriations of 1882.	Appropriations and allotments.	From sales, etc.	Total available.	Expended to May 31, 1894.	Expended during the month of June, 1894.	Total expended to June 30, 1894.	Total balances June 30, 1894.	Outstanding liabilities June 30, 1894.	Balances available June 30, 1894.
Survey of the Missouri River above the Missouri River Falls, Fort Benton, Mont		$15,000.00		$15,000.00	$15,000.00		$15,000.00			
Between Fort Benton, Mont., and Sioux City, Iowa:										
Office and inspection expenses of district officer	$2,000.00	4,749.00		6,749.00	6,749.00		6,749.00			
Purchase and repair of plant	2,000.00	58,751 00		60,751.00	60,751.00		60,751.00			
Work below Fort Benton		31,500 00		31,500.00	31,500.00		31,500.00			
Improving Missouri River between Sioux City and Fort Benton		48,250.00	$0.75	48,250.75	48,250.75		48,250.75			
Survey between Fort Benton and Sioux City		73,250.00	1.72	73,251.72	73,251.72		73,251.72			
Office expenses and expenses of Commission		5,000.00	53.24	5,053.24	5,053.24		5,053.24			
Expenses proper of Commission, gauges, and physical data		3,500.00	20.62	3,520.62	3,520.62		3,520.63			
	4,000.00	225,000.00	76.33	229,076.33	229,076.33		229,076.33			
Survey of Missouri River from its mouth to Fort Benton	8,844.39			8,844.39	8,844.39		8,844.39			
Between Sioux City, Iowa, and the mouth of the river:										
Office and traveling expenses and salaries of Commission		117,500.00	710.36	118,210.36	114,344.04	$633.66	114,977.70	$3,232.66	$1,714.76	$1,517.90
Additional surveys and establishment of permanent bench marks below Sioux City		48,000 00		48,000.00	48,000.00		48,000.00			
Care of plant, preservation and observation of gauges, and collection and compilation of physical data		37,000.00		37,000.00	37,000.00		37,000.00			
Purchase of tow boat		1 100.00		1,100.00	1,100.00		1,100.00			
Improving Missouri River in vicinity of Kansas City (at Parkville, Mo.)		491,851.96	42.36	491,894.32	491,894.32		491,894.32			
Improving Missouri River in vicinity of St. Joseph, Mo		287,269.98	13.12	287,283.10	287,283.10		287,283.10			
Improving Missouri River in vicinity of Kansas City, Mo		106,150.00		106,150.00	106,150.00		106,150.00			
Special surveys		14,500.00		14,500.00	14,500.00		14,500.00			
Expenses proper of Commission, gauges, and physical data		33,800.00	188.97	33,988.97	33,988.97		33,988.97			
Omaha, Nebr		120,736.64		120,736.64	120,736.64		120,736.64			
Sioux City, Iowa		80,411.67		80,411.67	80,411.67		80,411.67			
Rulo, Nebr		39,980.49		39,980.49	39,980.49		39,980.49			
Nebraska City, Nebr		60,298.92		60,298.92	60,298.92		60,298.92			
Atchison, Kans		60,639.14		60,639.14	60,639.14		60,639.14			

Leavenworth, Kans	....	60,213.71	....	60,213.71	60,213.71	....	60,213.71	....	....	....
Miami, Mo	....	19,787.67	....	19,787.67	19,787.67	....	19,787.67	....	....	....
Arrow Rock, Mo	....	36,294.98	....	36,294.98	36,294.98	....	36,294.98	....	....	....
Revetment in vicinity of Council Bluffs, Iowa	....	128,800.00	....	128,800.00	128,735.07	....	128,735.07	64.93	....	64.93
Completion of revetment on Nebraska City Island	....	2,500.00	....	2,500.00	2,500.00	....	2,500.00	....	....	....
Revetment in Belmont and Bon Ton bends	....	172,000.00	....	172,000.00	171,355.10	191.02	171,546.12	453.88	31.65	422.23
Repair and maintenance of works in vicinity of Kansas City	....	70,500.00	7.22	70,507.22	70,507.20	....	70,507.20	.02	....	.02
Systematic improvement in First Reach	....	1,127,200.00	100.00	1,127,300.00	1,109,462.90	7,109.01	1,116,571.91	10,728.09	5,634.30	5,093.79
Maintenance of gauges, collection of physical data, and publications	....	50,000.00	5.50	50,005.50	48,486.88	226.35	48,713.23	1,292.27	1,155.82	136.45
Surveys and examinations between Sioux City, Iowa, and the mouth of the river	....	91,275.00	52.94	91,327.94	91,275.80	....	91,275.80	52.14	52.14	....
Construction, repair and care of plant	....	439,764.84	....	439,764.84	439,523.20	....	439,523.20	241.64	....	241.64
Surveys and observations	....	30,000.00	....	30,000.00	23,193.27	200.00	23,393.27	6,606.73	1,330.00	5,276.73
Operating snag boat (removal of snags, etc.)	1,982.80	207,425.00	....	209,407.80	200,260.78	2,374.66	202,635.44	6,772.36	2,247.06	4,525.30
Surveys, gauges, physical data, and publications	....	15,000.00	....	15,000.00	13,102.01	....	13,102.01	1,897.99	970.65	927.34
Total	1,982.80	3,950,000.00	1,120.47	3,953,103.27	3,911,025.86	10,734.70	3,921,760.56	31,342.71	13,136.38	18,206.33
Grand total	14,827.19	4,190,000.00	1,196.80	4,206,023.99	4,163,946.58	10,734.70	4,174,681.28	31,342.71	13,136.38	18,206.33

Consolidated statement. July 5, 1884, to June 30, 1894.

Act of—		
July 5, 1884		$640,000.00
August 5, 1886		375,000.00
August 11, 1888		1,000,000.00
February 22, 1890		75,000.00
September 19, 1890		800,000.00
July 13, 1892		600,000.00
March 3, 1893		700,000.00
Total specific appropriations		4,190,000.00
Balances from former appropriations:		
Act of August 2, 1882, applied to works above Sioux City, Iowa	$4,000.00	
Survey Missouri River, from mouth to Fort Benton	8,844.39	
Act of August 5, 1886, applied to removing obstructions from Missouri River	1,982.80	
Total balances		14,827.19
Received from sales and deposits		1,196.80
Total available		4,206,023.99
Expended to June 30, 1894		4,174,681.28
Balance June 30, 1894		31,342.71

List of civilian engineers employed on work of river and harbor improvements in charge of Missouri River Commission from July 1, 1893, to June 30, 1894, inclusive, under the river and harbor acts of September 19, 1890 (improving Missouri River from its mouth to Sioux City, Iowa), July 13, 1892 (improving Missouri River from its mouth to Sioux City, Iowa), and March 3, 1893 (improving Missouri River from its mouth to Sioux City, Iowa).

Name and residence.	Time employed. Months.	Days.	Compensation per month.	Where employed.
Samuel H. Yonge, Osage City, Mo	12		$250.00	Osage City, Mo., first reach, Osage division.
S. Waters Fox, Gasconade, Mo	12		250.00	Gasconade, Mo., first reach, Gasconade division.
O. B. Wheeler, St. Louis, Mo		20	265.00	Special survey (includes subsistence)*
		11	225.00	Do.*
	10	29	200.00	St. Louis, Mo.
J. A. Seddon, St. Louis, Mo	12		200.00	Do.
A. H. Blaisdell, St. Louis, Mo	12		200.00	Do.
O. W. Ferguson, St. Louis, Mo	4	22	175.00	Do.
C. M. Winchell, St. Louis, Mo	11	8	175.00	Do.
		22	150.00	Do.
A. N. Darrow, St. Louis, Mo	4		150.00	Do.
R. H. Bacot, Osage City, Mo	12		150.00	Osage City, Mo., first reach, Osage division.
J. C. Meredith, Gasconade, Mo	12		150.00	Gasconade, Mo., first reach, Gasconade division.
O. H. B. Turner, St. Louis, Mo	2	24	187.50	Special survey (includes subsistence)*
	1	11	150.00	Do.*
	7	25	137.50	St. Louis, Mo.
L. P. Butler, St. Louis, Mo		6	162.50	Special survey (includes subsistence)*
	11	24	125.00	St. Louis, Mo.
A. L. Johnson, St. Louis, Mo		3	125.00	Do.
Ed. Jones, Gasconade, Mo	9		125.00	Omaha, Nebr., St. Joseph, Mo., Omaha and St. Joseph division.
	3		90.00	Gasconade, Mo., first reach, Gasconade division.
R. A. Crawford, Osage City, Mo	6		125.00	Osage City, Mo, first reach, Osage division.
	6		100.00	
A. H. Weber, Osage City, Mo	11	12	125.00	Osage City, Mo., first reach, Osage division.
G. F. Bird, Gasconade, Mo		17	120.00	Gasconade, Mo., first reach, Gasconade division.
Chas. E. Taylor, St. Louis, Mo	4		110.00	St. Louis, Mo.
J. Wm. Link, St. Louis, Mo	3		110.00	Do.
E. D. Williams, St. Louis, Mo	12		100.00	Do.
S. A. Benedict, Osage City, Mo	2		100.00	Osage City, Mo., first reach, Osage division.
W. R. De Witt, Gasconade, Mo	1	28	100.00	Gasconade, Mo., first reach, Gasconade division.
J. G. Gilchrist, Gasconade, Mo	1		100.00	Do.
Bathurst Smith, Gasconade, Mo	1		100.00	Do.
J. G. Auld, Gasconade, Mo	1		100.00	Do.

*On survey of Missouri River.

APPENDIX A.

ANNUAL REPORT OF THE SECRETARY OF THE MISSOURI RIVER COMMISSION, 1894.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1894.

SIR: I have the honor to submit the following report of the work in charge of the secretary of this Commission for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

JAMES F. MCINDOE,
Additional Second Lieut. of Engineers,
Secretary.

Lieut. Col. CHAS. R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

This work was in charge of First Lieut. James C. Sanford, Corps of Engineers, until June 16, 1894; in charge of the president of the Commission from June 16 to 20, 1894, and since the latter date, in my charge.

SURVEYS.

Secondary triangulation.—On July 23, 1893, a small party under Assistant Engineer O. B. Wheeler, was sent to Jefferson City, Mo., to set a geodetic and elevation monument in the State capitol grounds, and to determine and mark its latitude, longitude, and elevation by connection with the Commission's secondary triangulation system and line of precise levels; also to set a small marking stone which, with the above monument, should indicate a true meridian. On the completion of this work, August 3, the party proceeded to Kansas City, where they connected the Commission's secondary triangulation system with the primary system of the U. S. Coast and Geodetic Survey. In addition to this two monuments on the Kansas-Missouri State line and a permanent point on the boundary between Platte and Clay counties, Mo., were located; six triangulation points for future harbor use were located and marked in Kansas City, Mo., and Kansas City, Kans.; and the azimuth of three bridges determined. The field work was completed August 23. For details of this work and its reduction see Assistant Engineer Wheeler's report. (Appendix A 1.)

Mapping.—Of the series of maps of the Missouri River to be photolithographed, comprising 83 inch-mile maps and 9 index maps, and extending from the mouth of the river to Three Forks, Mont. (numbering begins from mouth), the status at the beginning of the fiscal year was as follows:

The originals of inch-mile maps Nos. 1-16, 18, 19, 22, 24-27, and 73-83, and of index map No. 9, had been completed; and those of inch-mile maps Nos. 17, 20, 21, 23, and of index map No. 1, were in progress. Inch-mile maps Nos. 1-14, 76, 77, and 80-83 had been published. Inch-mile maps Nos. 15, 16, 18, 19, 22, 24-27, 78, and 79, and index map No. 9, were in the hands of the printer. Proofs had been received of inch-mile maps Nos. 24, 25, 78, and 79, and had been returned for printing.

During the present fiscal year inch-mile maps Nos. 17, 20, 21, 23, and 41-72, covering 1,145 miles, river distance, and index maps 1-3 and 6-8, have been completed. Inch-mile maps Nos. 28-38, covering 311 miles, river distance, and index maps Nos. 4 and 5, are yet to be completed. Inch-mile maps Nos. 39 and 40, and index maps Nos. 4 and 5, are in progress.

Printed editions of inch-mile maps Nos. 15-27, 54, 56, 61-75, 78, and 79 and index maps Nos. 1-3 and 9 have been received during the year. Nos. 41-53, 55, and 57-60 and index maps Nos. 6-8 are in the hands of the printer. Proofs of inch-mile maps Nos. 57-60 have been received, corrected, and returned for printing.

On the office detail maps (scale 1 inch = 1,000 feet) corrections, additional information, titles, and scales have been put on Nos. 1-27 (mouth to Sioux City) and on the 32 maps from Fort Benton, Mont., to Three Forks, Mont. Reference notes and authorities have also been put on the latter 32 maps, and on an office index map (scale 1 inch = 2 miles) covering the Fort Benton-Three Forks section of the river.

A comparative map has been begun, on which are to be platted, one above another, the results of annual surveys of the Jefferson City reach from Claysville to Isbell, and the platting of the results of the surveys of 1890, 1891, 1892, and 1893 is nearly completed.

All mapping work has been under supervision of Assistant Engineer O. B. Wheeler.

Levels.—The reduction of the notes of precise level work, done between May 22 and June 27, 1893, by the party under Assistant Engineer O. H. B. Turner, in con-

necting with the precise level line of 1892 the Commission's gauges at Blair, Nebr.; Plattsmouth, Nebr.; Nebraska City, Nebr.; Rulo, Nebr.; Brownville, Nebr.; Randolph, Mo., and Dewitt, Mo., referred to in Secretary's last Annual Report, was completed in the office.

A small party under Assistant Engineer Turner was engaged between September 23 and November 3, 1893, in connecting by carefully checked Y levels with the precise level line such stone lines as had not been been connected with when the precise level line was run. Levels were also rerun by the party over ten stone lines, on which the original notes showed that the levels had not been properly checked. The notes of the party's work have since been reduced in the office.

Comparative profiles were made showing, from St. Joseph to the mouth, the discrepancies between the Commission's direct and reverse precise level line of 1892, the precise level line of the U. S. Coast and Geodetic Survey, and the Commission's stone line levels of 1884-1890. The locations of all the precise level bench marks from the mouth of the river to Sioux City have been plotted on the office detail maps. The level notes of all the stone lines, from the mouth to Sioux City and from Fort Benton, Mont., to Three Forks, Mont., have been recomputed. A list and descriptions of all the Commission's bench marks between these same points are being prepared for publication and are nearly completed.

Full details of the year's level work in field and office will be found in Assistant Engineer Turner's report (Appendix A 2).

Special Surveys.—A survey was made December 18-21, 1893, at the St. Charles bridge, to determine locations and elevations of obstructions, composed of loose rock and remains of old cribs and dykes, under and near the first span from the St. Charles side.

Careful measurements were made at the two bridges over the Missouri River below Sioux City—Bellefontaine Bluffs, Missouri and Leavenworth, Kans.—completed during the fiscal year, to determine the lowest points of superstructure, clear opening between piers, and width and batter of piers.* At the latter bridge a survey was also made to determine location of certain dikes constructed by the bridge company.

The following special surveys were made under the direction of the division engineers during the year:

Little Tavern Creek, Missouri, to Rhineland Landing, Missouri.

Missouri River at Murrays Bend.

Missouri River at Barkersville Crossing.

Head of Stanley Island, Missouri, to Little Tavern Creek, Missouri.

Osage Point, Missouri, to Hords Landing, Missouri.

Little Tavern Creek, Missouri, to mouth of Gasconade River, Missouri.

In addition to the above, Division Engineer Fox kept a small survey party almost continuously in the field during construction operations, sounding on ranges and dike lines, giving grade and line to dike parties, on slope observations, partial shore line work, establishment and verification of local gauges, and in miscellaneous work incident thereto.

GAUGES AND PHYSICAL DATA.

At the date of the last Annual Report 21 permanent gauges were maintained by the Commission. These have been read continuously during the year. The readings of the standard cable gauge on the bridge at Randolph, Mo., began July 2, 1893, and have since been continuous. A standard cable gauge was established March 13, 1894, on the new railway bridge at Bellefontaine Bluffs, Missouri, and has since been read regularly. In addition to these temporary gauges have been maintained by the division engineers, readings of which have been sent weekly to this office as follows: From Ewings Landing, Missouri, throughout the year; from Herman, Mo., for 7½ months, and from Gasconade, Mo., for 7⅙ months. Readings have also been received weekly throughout the year from the gauge at Bismark, N. Dak., and for portions of the year from the gauges at Fort Benton, Mont.; Wolf Point, Mont.; Fort Buford, N. Dak., and Running Water, S. Dak. Through the courtesy of Capt. H. F. Hodges, Corps of Engineers, the Commission has been furnished with all records of the upper river gauges on file in his office, thus completeing the record of all gauges on the river to the end of the present fiscal year.

Three complete tours of inspection of all the gauges below the Big Sioux River have been satisfactorily made during the year by Assistant Engineer L. P. Butler; one in September, 1893; one in November and December, 1893, and one in May and June, 1894. At the November-December inspection all the gauges were regraduated or so changed as to read precise level elevations above the St. Louis Directrix. New

* The results of these measurements are shown in the table appended (Appendix A 3) and on the accompanying plate.

inclined wooden gauges were erected at Brownville, Nebr., and Dewitt, Mo., and all necessary repairs to the gauges were made.

The pilot bulletin service, exhibiting the daily stage of the river at all the Commission's gauges below Kansas City, was discontinued for the winter at the end of November. The service at Kansas City was, at the request of local steamboatmen, continued through the winter. At the guage stations below Kansas City the service was resumed March 16. A bulletin was erected in the spring on the new bridge at Bellefontaine Bluffs, Missouri, exhibiting its first reading April 16. The bulletins indicate heights above a zero 5 feet below the mean low-water stage during navigation seasons at each station; and their readings should agree exactly with those of the Weather Bureau at Kansas City, and should differ but slightly therefrom at other stations.

Full details of the year's gauge work will be found in the report of Assistant Engineer A. H. Blaisdell. (Appendix A 4.)

The results of borings made in the river valley at Leavenworth, Kans., Jefferson City, Mo., and St. Charles, Mo., since the date of the last report on borings, will be found in an appended report. (Appendix A 5.)

Assistant Engineer J. A. Seddon has carried his study of flood movement as far up the river as Kansas City, and has made a preliminary study of regimen throughout the same length of river. The outline is given in his report. (Appendix A 6.)

Assistant Engineer C. M. Winchell has prepared an index of the survey and physical data published in the annual reports of the Missouri River Commission from 1885 to 1893, inclusive. (Appendix A 7.)

COMMERCIAL STATISTICS.

Methods similar to those of last year have been followed for obtaining the amount of commerce on the Missouri River for the calendar year 1893. The results are given in the report on this subject appended. (Appendix A 8.)

ESTIMATES.

Office and traveling expenses and salaries of commission	$20,000
Surveys, gauges, physical data, and publications	30,000
Total	50,000

APPENDIX A 1.

ANNUAL REPORT OF O. B. WHEELER, ASSISTANT ENGINEER, 1894.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1894.

SIR: I have the honor to report herewith upon the field work and reductions of survey work done by Assistant Engineer O. H. B. Turner and myself in July and August last, viz:

First. Setting a geodetic and elevation monument, together with a meridian stone on the State capitol grounds at Jefferson City, Mo.

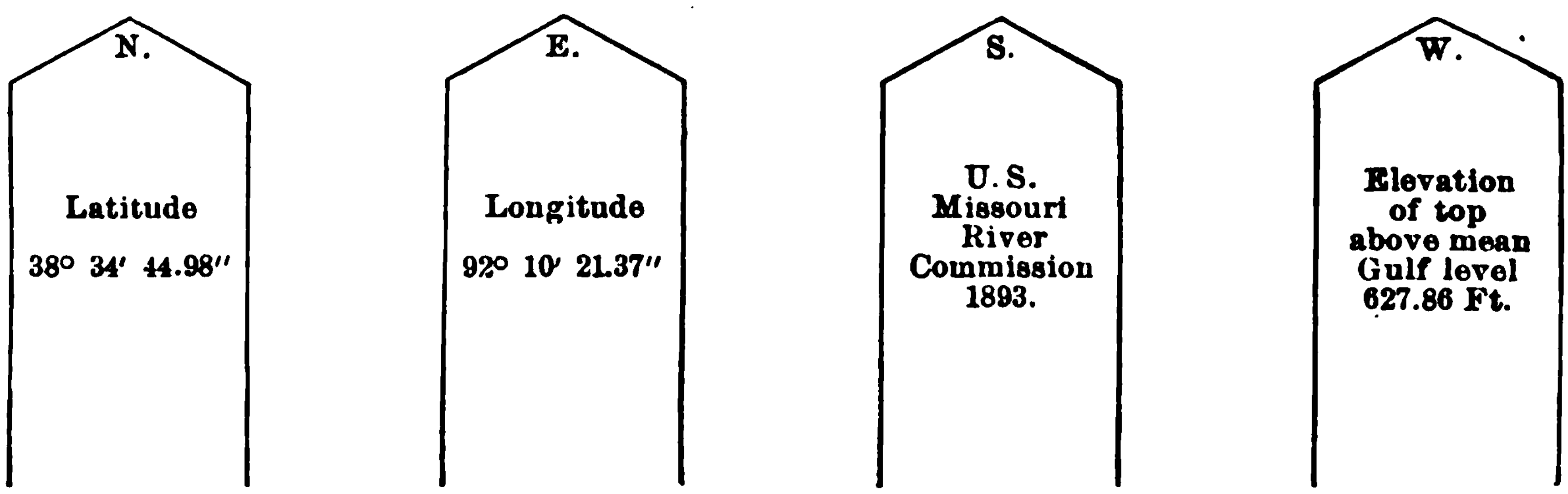
Second. Connecting the commission's secondary triangulation system with the primary triangulation system of the U. S. Coast and Geodetic Survey at Kansas City, Mo.

The purpose of the monuments at Jefferson City is to record latitude, longitude, elevation, and a true meridian on the State capitol grounds. The stones are of Missouri red granite, or syenite, and are of the following dimensions: The larger one is 20 inches by 20 inches in section and 81 inches long over all; the smaller, 8 inches by 8 inches in section and 57½ inches long over all. Both stones are placed 48 inches in the ground and for this length have the quarry face. For 30 inches above the ground the larger stone is dressed and polished on all sides and terminates at the top in a truncated pyramid 3 inches in height with an upper base 1½ inches square.

For 8 inches above the ground the smaller stone is patent hammer dressed on three sides and dressed and polished on the fourth, and terminates at the top in a truncated pyramid 1½ inches high with an upper base 1½ inches square. In each stone in the center of the small upper base is set vertically a bolt of hard-hammered brass one-half inch in diameter and 2¾ inches long with a slightly convex head. A hole of one-sixteenth inch diameter and one-half inch deep is drilled vertically

through the center of each convex head, and these are the points astronomically and hypsometrically located.

The following diagrams give the wording on the different faces of the main monument:



On the north face of the smaller stone is lettered: U. S. Mo. R. C. 1893. This meridian stone is 426 feet south from the main monument.

The latitude and longitude given depend upon the astronomical determination of the dome of the Morrison Observatory at Glasgow, Mo., as published in Publications of the Morrison Observatory, Glasgow, Mo., 1885, and as transferred to Jefferson City by the secondary triangulation of the Missouri River, under the Missouri River Commission, which is published in their annual report for 1887.

The elevation given depends upon the elevation of the St. Louis City directrix as determined by the Mississippi River Commission and published in their annual report for 1883, and upon a line of precise levels run by the Missouri River Commission in 1892 and published in their annual report for 1893.

The geodetic position of the dome of the capitol is: Latitude = 38° 34′ 45.22″: longitude = 92° 10′ 22.64″.

This position will be found to differ from that furnished in manuscript in 1892 to the Commission by the U. S. Coast and Geodetic Survey (which was from an astronomical determination in 1881 at St. Louis, Mo., as transferred by triangulation) by 6.22″ in latitude and 2.06″ in longitude, the Coast Survey determination being greater in latitude and less in longitude. It would differ much less from a determination of the Mississippi River Commission at Cairo, Ill., if the latter is transferred by triangulation. These differences are principally due to what is known as local deviation of the plumb line.

The elevation will also be found to differ from that derived from the Coast Survey, being about 1 meter greater than that of the Coast Survey if their value from Mobile, Ala., be adopted, or about eight-tenths of a meter less if their value from Sandy Hook, N. J., be adopted.

The stones were dressed, polished, and lettered by Filsinger & Fruth, of St. Louis, Mo., and the U. S. Steamer *Wm. Stone* delivered them on the river bank at Jefferson City.

Under the instructions of the secretary of the Commission Assistant Engineer O. H. B. Turner and myself left St. Louis on July 23 and on the 24th met Division Engineer Yonge at Jefferson City, who rendered us every assistance. The governor and secretary of state were called upon to assist in giving the exact site for the main monument, which was practically that selected by the secretary of the commission earlier and was upon the grass plat of the upper terrace just to the right, or north, of the main entrance to the capitol.

The setting was done by day labor. For each stone a bed of concrete, 4 feet by 4 feet by 1 foot, was placed 4 feet below the surface of the ground and allowed one day to set. The stone was set upon this, carefully oriented and plumbed and concreted to within one-half foot of the surface of the ground. Before the smaller stone could be set or the final figures for latitude, longitude, and elevation could be cut it was necessary to make a geodetic connection with stations of secondary triangulation and to get the elevation of the top of the monument above a precise level bench mark. It was found that △ Cedar (which is also a Coast Survey station) 2¼ miles northeast from the capitol, had been disturbed by some one in search for Indian relics in the mound upon which it is located and all the surface reference stones had been removed. A pickle bottle, filled with wood ashes, was found 18 inches below the disturbed surface and was no doubt the subsurface mark of the Coast Survey and probably in its original place; but it seemed advisable to check its position. Accordingly △ Ulrich and △ Ewing were occupied with the Troughton & Simms 12-inch

theodolite of the Mississippi River Commission. The third angle at △ Cedar (approximate) was read and computation made to restore △ Cedar to its former old position and to leave the values published on page 3048 of the Chief of Engineer's Report for 1887 undisturbed. To mark the restored △ Cedar the usual subsurface stone of the Commission was placed 5 feet below the surface. The surface stone of the Coast Survey was placed above and their reference stones were placed as follows. On the meridian to the north at a distance of 80 feet measuring down the hillside, which is depressed at an angle of 17° with the horizon, one stone was set, and on the meridian to the south at a distance of 118.25 feet measuring down the hillside, which is depressed at an angle of 14½° with the horizon, the other reference stone was set.

Careful angles were then read with the theodolite above mentioned at △ Cedar and at the main monument for the transfer of the azimuth of the line △ Cedar — △ Ulrich to a true meridian line at the main monument, and the smaller stone was set on this meridian at a distance of 426 feet south.

The geodetic positions above given are from carefully read angles at stations Cedar, Ewing, and Ulrich, and the elevation is determined with a Kern precise level from T. B. M. 197 (on circular step in front of main entrance to capitol), checked by readings on U. S. C. S. B. M. XXVII, values and descriptions for which bench marks were published in the last annual report.

Final position.—The top of the main monument is 0.86 foot above T. B. M. 197. It is 24.6 feet south and 100.4 feet east from the center of the dome of the capitol. From it △ Cedar is 11,108.1 feet and bears N. 45° 21′ 13″ E.

The latitude, longitude, and elevation are, as above given, viz:

Latitude	38° 34′ 44.98″
Longitude	92° 10′ 21.37″
Elevation above mean gulf level	627.86 feet.

We left Jefferson City on August 3 and arrived at Kansas City, Mo., on the same day.

The primary triangulation stations of the U. S. Coast and Geodetic Survey easiest of access were △ Bowler, 17 miles southeast from Kansas City, and △ Marty, in Kansas, 10 miles southwest from Kansas City. The line connecting these stations is 17 miles in length, and the stations are intervisible from the surface of the ground; but to reach Kansas City it was necessary to locate a third station, △ Rice, on a high ridge 9 miles south from Kansas City. Angles were read from these three stations with the Troughton & Simms 12-inch theodolite, using small (three-fourths inch) heliotrope lights for targets. The usual eight sets of repetitions of each angle were generally obtained. Numerous points were read upon in Kansas City and Independence, but only two located which were identical with points located from the secondary triangulation of the Missouri River. A section corner stone on the State line between Missouri and Kansas was located.

To locate more points in the vicinity of Kansas City, △ Buster and △ Wayne of the secondary triangulation were occupied with the Troughton & Simms 12-inch theodolite, and the usual eight sets obtained on each angle. Some of the points thus located were occupied with the small theodolite, Buff & Berger No. 176, and the work was carried on with the smaller instrument. Nine points were thus located and marked, when practicable—one of these being on the State line on the Armour packing house, and one on the line between Platte and Clay counties on the north side of the river at the water's edge.

The data from the Coast Survey used is from the manuscript of 1892, above referred to, and is as follows:

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
△ Bowler	38 53 20.659	94 23 40.111
△ Marty	38 59 27.390	94 40 15.638

Azimuth △ Bowler to △ Marty	115° 20′ 19.38″
Azimuth △ Marty to △ Bowler	295° 09′ 53.68″
Distance △ Bowler to △ Marty ....meters	26,509.27

From this data, in connection with our angle, the position of the tower of the courthouse at Independence is:

Latitude = 39° 05′ 37.30″, longitude = 94° 24′ 58.16″.

The position also from the main spire of the Central Presbyterian church, in Kansas City, Mo., is:

Latitude = 39° 06′ 14.09″, longitude = 94° 34′ 15.99″.

The positions of these same two points when made to depend upon data of the Missouri River triangulation given in the Commission's report for 1887 and our present angles are:

	Latitude.			Longitude.		
	°	′	″	°	′	″
Independence court-house	39	05	20.89	94	24	59.66
Central Presbyterian church	39	06	07.63	94	34	17.46

Or the difference in position as given by the two systems of survey for the court-house is 6.41″ in latitude and 1.50″ in longitude; the Coast Survey determination being greater in latitude and less in longitude. A like comparison at Jefferson City, noticed earlier in this report, gives 6.22″ in latitude and 2.06″ in longitude. Hence the discrepancy between the two surveys is 6.41″—6.22″=+0.19″=+19 feet in latitude and 1.50″—2.06″=—0.56″=44 feet in longitude in a net of triangulation of about 160 miles length between Independence and Jefferson City. Since the azimuth error in this nearly east and west direction can affect the discrepancy in longitude but little, this 44 feet may be taken to represent the approximately true discrepancy in distance between the two surveys. This discrepancy is approximately three-tenths of a foot in a mile, or one in 15,000, and is too small to be shown on the scale of any map covering so great a distance.

The following tables give the geodetic positions of points in the vicinity of Kansas City referred to the latitude and longitude of Morrison Observatory, or to the data of the Commission as given in their report for 1887:

Station.	Latitude.			Longitude.		
	°	′	″	°	′	″
Bowler (U. S. C. and G. S.)	38	53	14.25	94	23	41.61
Marty (U. S. C. and G. S.)	38	59	20.98	94	40	17.14
Rice (U. S. C. and G. S.)	38	59	50.80	94	28	50.58
Court-house (cupola) Independence	39	05	30.89	94	24	59.66
Central Presbyterian church (spire)	39	06	07.63	94	34	17.46
Second Presbyterian church (spire U. S. C. and G. S.)	39	05	54.02	94	35	15.52
Cathedral spire (U. S. C. and G. S.)	39	06	01.33	94	35	22.51
College of Redemptorist Fathers, cupola (U. S. C. and G. S.)	39	03	59.75	94	35	21.63
State line (stone 3) Missouri and Kansas (U. S. C. and G. S.)	38	46	01.02	94	36	32.19
State line (stone 1) Missouri and Kansas (U. S. C. and G. S.)	38	52	59.74	94	36	30.20
State line (stone section corner) Missouri and Kansas	38	58	15.22	94	36	30.11
State line (stone 2) Missouri and Kansas (U. S. C. and G. S.)	38	59	08.59	94	26	31.57
State line (Armour) Missouri and Kansas	39	06	18.97	94	36	26.80
County line between Platte and Clay counties which was originally the Missouri State line	39	09	37.20	94	36	07.15
Bridge (north end embankment), Chicago, Milwaukee and St. Paul R. R	39	08	50.16	94	32	05.84
Bridge (north pier, east side), Hannibal and St. Joseph R. R	39	06	51.10	94	35	22.37
Bridge (north pier, east side), Missouri Pacific R. R., Kaw River	39	06	47.28	94	36	53.60
New York Life (roof, northeast corner)	39	06	12.86	94	35	02.98
Evans (roof over elevator shaft)	39	06	27.17	94	35	23.45

Stations.	Azimuth.			Back azimuth.			Distance.	
							Feet.	Meters.
	°	′	″	°	′	″		
Rice to Bowler	328	39	28.6	148	42	42.8	46,961.33	14,313.69
Rice to Marty	86	52	27.2	266	45	15.2	54,295	16,548.98
Rice to court-house	207	52	33.0	27	54	58.5	38,931.3	11,866.1
Rice to Central Presbyterian church	145	57	01.8	325	53	35.8	46,035.2	14,031.4
Marty to Central Presbyterian church	214	33	31.4	34	37	18.0	49,982.3	15,234.5
Buster to court-house	323	23	00.5	143	25	57.2	37,013.8	11,281.7
Wayne to court-house	5	44	20.0	185	44	03.0	21,203	6,462.6
Wayne to Central Presbyterian church	69	23	09.8	249	17	00.9	49,247.7	15,010.6
Buster to Central Presbyterian church	40	07	02.2	220	04	06.9	33,988.6	10,359.6
Wayne to bridge, Chicago, Milwaukee and St. Paul	88	32	43.7	268	27	57.7	35,704.7	10,882.7
Kansas City to bridge, Chicago, Milwaukee and St. Paul	202	36	35.9	22	37	14.7	12,589.5	3,837.2
Kansas City to New York Life	64	48	18.3	244	47	05.3	10,079.9	3,072.3
Bridge, Chicago, Milwaukee and St. Paul to New York Life	41	16	30.7	221	14	38.9	21,171.3	6,453
Kansas City to bridge, Hannibal and St. Joseph	87	44	00.6	267	42	35.4	10,656.1	3,247.9
New York Life to bridge, Hannibal and St. Joseph	158	26	50.5	338	26	38.3	4,159.9	1,267.9
Kansas City to Evans	75	10	08.4	255	08	42.5	11,104.6	3,384.7

Stations.	Azimuth.			Back azimuth.			Distance.	
							Feet.	Meters.
	°	′	″	°	′	″		
New York Life to Evans	131	52	59.5	311	52	46.6	2,167.7	660.7
Kansas City to bridge, Missouri Pacific	87	25	06.3	267	22	43.5	17,856	5,442.4
Evans to bridge, Missouri Pacific	105	59	02.5	285	58	05.6	7,393.2	2,253.4
Evans to Armour	80	34	49.6	260	34	09.6	5,062.2	1,542.9
Bridge, Hannibal and St. Joseph to Armour	57	23	07.9	237	22	27.3	6,030.4	1,838.1
Bridge, Hannibal and St. Joseph to bridge, Missouri Pacific	86	55	39.2	266	54	41.6	7,203.1	2,195.5
Kansas City to point on county line	139	09	00.4	319	07	06.4	21,661.6	6,602.4
Evans to point on county line	169	51	08.2	349	50	41.2	19,532.6	5,953.5

	°	′
Azimuth of Chicago, Milwaukee and St. Paul Railroad bridge	158	55
Azimuth of Hannibal and St. Joseph Railroad bridge	160	48
Azimuth of Missouri Pacific Railroad bridge	162	19

DESCRIPTIONS OF POINTS PERMANENTLY MARKED.

Descriptions of stations Buster, Wayne, and Kansas City are given in the Commission's report for 1887. Those stations marked U. S. C. & G. S. may be had from the U. S. Coast and Geodetic Survey Office, and the new ones which it was practicable to mark are as follows:

Rice is about 1¼ miles southwest from Raytown, Mo., on a high ridge between the Little and Big Blue rivers, on land owned by Mr. E. C. Rice. It is near the center of the SW. ¼ of the NW. ¼ of sec. 8, T. 48 N., R. 32 W. It is 120 paces south from the north side of the 40 and 174 paces east from the stone fence of the road along the west side of the 40 paces (assumed to be 3 feet each). It is marked by a 2-inch iron pile 4½ feet in length, driven down nearly flush with the surface of the ground.

Section corner on State line is that between the fractional sections 26 and 35 of T. 12 S. and R. 23 E. from the sixth principal meridian.

Bridge, Chicago, Milwaukee and St. Paul, is 128.5 feet northerly from the center of the north pier of the Chicago, Milwaukee and St. Paul Railroad bridge, in line with the west guard rail prolonged, is on the curved embankment 5 feet west from the west rail, and about 4 feet east from a signal post. It is a gas pipe driven into the ground with its top 3 inches below surface.

Bridge, Hannibal and St. Joseph, is a nail of the survey of 1890 driven in a masonry joint on the east end of the north pier of the Hannibal and St. Joseph Railroad bridge.

Bridge, Missouri Pacific, is on the east end of the north pier of the Missouri Pacific Railroad bridge over the Kaw River. It is a nail wedged between the iron bed plates and is 5 inches west from the east edges of the bed plates.

New York Life is on the roof of the New York Life Insurance building, near the northeast corner. It is a cross cut in the tile of the roof at a distance of 2.68 feet from the east wall and 2.50 feet from the north wall.

Evans is on the building of the Evans Drug Company, on Fifth street near Washington street. It is on the roof of the elevator shaft at the northwest corner of the building and is marked by the head of a screw.

Armour is on the State line, on the south wall of the office of the Armour packing house. It is marked by a cross cut in a brick. The State line is also marked by a vertical line on the wall of the south side of said office.

Point on county line is on the county line between Platte and Clay counties, Mo. It is a fence post 55 feet south from the center of the railroad track and at the water's edge on the north side of the Missouri River.

In the office reduction of the notes I have been assisted by Assistant Engineer Turner and Computer C. E. Taylor.

Very respectfully, your obedient servant,

O. B. WHEELER,
Assistant Engineer.

APPENDIX A 2.

ANNUAL REPORT OF O. H. B. TURNER, ASSISTANT ENGINEER, 1894.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1894.

SIR: I have the honor to submit the following report on field and office work under my charge for the past year.

It was decided in September to send out a party to connect with the line of precise levels, by a carefully checked line of levels, all bench marks and stone lines,

which had not been connected at time of running the precise line on account of their distance from it; nor had any connection by wye levels been run at time stone line was put in, as the bench marks of 1880 and 1881 from which the stone lines were established were found to be unreliable.

The party left St. Louis, September 23, for Crescent, Iowa, the farthest point at which work was required.

The party consisted of an assistant engineer and two rodmen, and such additional force as was required was employed where necessary. This was done to save transportation.

Work was begun on September 25 and continued until November 3, when work was completed at Boonville, Mo.

As stone lines 48–41, inclusive, had been leveled in one direction, they were considered unreliable and it was thought best to rerun them. Assistant Engineer L. P. Butler reported at Glasgow, Mo., October 25, to assist in rerunning these lines, as the river crossings could be made much better by two parties than by one.

With but two exceptions these isolated stone lines and benches were connected with precise bench marks, and in these cases, connection was made to benches that were reliable.

No very large discrepancies were found, except on stone line No. 101, where an error of nearly 2 feet was discovered. There were several discrepancies of from 1 to 0.2 of a foot.

All stone lines and bench marks that were doubtful were rerun or good connection made to reliable benches.

There were 70 miles of checked levels run and 8 river crossings made. Party was out forty-two days, including time in going from St. Louis to the field and in returning.

The total cost of survey, including transportation and expressage of instruments, was $719.90, or $10.28 per mile of checked levels. The cost per mile, exclusive of transportation and expressage of instruments, was $8.35.

Bench mark No. $\frac{77}{2}$ has been washed out by the river; No. $\frac{45}{2}$ could not be found, and was said to have been covered by driftwood and deposits of sand.

Since returning from the field the notes have been checked and the new values of bench marks tabulated.

The field notes of precise level survey of May and June have been reduced and checked, descriptions of bench marks have been written up, and all are now in form for publication. No errors were found in the field notes, and all lines check within the precise limit.

The probable error per kilometer for the whole line is ± 0.67 mm.

The precise leveling rods X and XIII have been compared with the standard meter of Mississippi River Commission and found to be of normal length.

These rods were compared in April, 1863, by Assistant Engineer O. W. Ferguson, and found to have been long, but as they had just returned from a field season near the gulf, no weight was given to that comparison.

For my report on field operations see Appendix A 7 of report of Missouri River Commission for 1893.

On account of so many large discrepancies being found between the precise levels and the ordinary levels, two of which proved on examination to be errors of computation, it was decided to recompute the level notes over stone lines from the mouth of river to Sioux City, Iowa, and from Fort Benton to Three Forks, Mont.

The large discrepancies between the precise and the ordinary levels were found to be due (1) to errors in the field notes, lines not checking and this fact not being discovered; or (2) to errors of computation; or (3) to stone lines having been put in from old bench marks which either were not identified or were in error.

Quite a number of small changes were made from the former reduction.

The elevations of the bench marks as reduced depend on precise bench marks, generally not more than 3 or 4 miles distant; so no large discrepancy may be expected.

The level notes between Fort Benton and Three Forks, Mont., were recomputed and a correction of +13.522 feet was applied to elevation of B. M. $\frac{1}{2}$, at Fort Benton. This elevation of B. M. $\frac{1}{2}$ was brought down from Northern Pacific Railroad levels at Gallatin, Mont., by Assistant Engineer G. A. Marr in 1890.

The correction of +13.522 feet depends on elevation of B. M. $\frac{1}{2}$, at Fort Benton, as determined from the precise benches of Missouri River Commission at Sioux City, Iowa, by survey parties under Capts. C. F. Powell and H. F. Hodges and the Missouri River Commission.

A book of bench marks is now being prepared and is nearly completed. This book will contain (1) all bench marks of 1881 and 1882, also those of former surveys that were connected with at that time; (2) all bench marks of stone lines put in from 1884 to 1890; (3) all precise bench marks of 1887, 1892, and 1893 also all precise temporary bench marks that were considered sufficiently permanent for future use.

It is proposed to designate the degree of accuracy of these bench marks by names and by the use of large and small type.

The bench marks included in this book are from mouth of river to Sioux City, Iowa, and from Fort Benton, Mont., to Three Forks, Mont.

The precise bench marks from Sioux City, Iowa, to St. Joseph, Mo., have been platted on the detail maps, scale 1 inch = 1,000 feet. At time of running precise line accurate stadia distances were taken to located points of topography, and as line of levels was along the railroad the bench marks have been platted on the detail sheets with about the same degree of accuracy as that of the adjacent topography.

Summary of work done by Assistant Engineer O. W. Ferguson:

The remaining work on field notes that was unfinished at end of fiscal year 1893 was completed.

The precise and temporary precise bench marks were platted on detail sheets, scale 1 inch = 1,000 feet, from St. Joe to mouth of river.

Several profile sheets were made in office:

One showing the discrepancies between the Missouri River Commission precise-level line and the bench marks connected with by precise-level party from St. Joe to mouth of river;

A second showing discrepancies between direct and reverse precise level line, from St. Joe to mouth of river;

A third showing discrepancies between U. S. Coast and Geodetic Survey and Missouri River Commission's precise levels from Kansas City to St. Louis; and

A fourth showing limit of error of closure between precise-level lines over same stretch.

The following is a summary of work of Y level survey under my charge:

Party was out forty-two days, including time in going to and from work.

	Miles.
River distance covered	467
Line leveled and checked	70
River crossings made	8
Precise bench marks connected with	25
Ordinary bench marks connected with	37
Stone lines connected with	21
Stone lines rerun	10

Very respectfully, your obedient servant,

O. H. B. TURNER,
Assistant Engineer.

DESCRIPTIONS AND ELEVATIONS OF PRECISE LEVEL BENCH MARKS OF SPECIAL SURVEY FROM BLAIR, NEBR., TO DE WITT, MO.

All elevations are given in both meters and feet, and refer to St. Louis City directrix as zero. The elevation of this above Biloxi sea level is 412.731 feet.

A P. B. M. is a precise bench mark that is set to be practically permanent.

All P. B. Ms., excepting 327 B, which is a cross on B. M. stone, are (1) top of copper bolts in regulation B. M. stone, or (2) center of copper bolt set horizontally, or (3) marks on bridge piers.

The value of the meter used is 3.2808693 feet.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
P. B. M. 360 = $\frac{1\,7}{3}$	Is 758 feet east of the depot at California Junction, Harrison County, Iowa, in the northwest corner of A. W. Smith's orchard, 3 feet from each fence and 56 feet south of St. Croix and Penobscot Ry.; being copper bolt in B. M. stone	179.8660	590.117
Top of cap, P. B. M. 360 = $\frac{1\,7}{3}$.	....	181.0862	594.120
P. B. M. 360 A	Is about $2\frac{7}{8}$ miles west of California Junction, Iowa, 272 feet northeast from Fremont Zimmerman's house, about 320 feet east from west line of section 17, 39 feet south from track center of the Fremont, Elkhorn and Missouri Valley Railroad, and 5 feet north of south right-of-way fence. The bench is a cross (+), cut in regulation stone, $\frac{1}{2}$ inch east of hole in center and next to the letters U. S.	180.7110	592.889
Top of cap, P. B. M. 360 A.	....	181.9554	596.972
P. B. M. 360 B	Is on west pier of railroad bridge across Missouri River, near Blair, Nebr. Is center of circle on west coping stone on south end of west pier. The letters B. M. are cut in stone just north of bench.	194.3163	637.526

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 360 C= ${}^{1}_{3}{}^{7}$	Is on west pier of railroad bridge across Missouri River, near Blair, Nebr. Is □ cut on top of coping of north end of pier with the letters U. S.	194.3118	637.512
Gauge B. M., Blair, Nebr.	Is on west pier of railroad bridge across Missouri River, near Blair, Nebr. The bench is in south side of pier, in third course of masonry, below lower coping stone, is upper surface of a projection 0.5 feet below top of stone 2.3 feet northwest from south corner of pier.	181.2517	594.663
P. B. M. 336= ${}^{1}_{3}{}^{7}$	Is about 1¼ miles southwest of Pacific Junction, Mills County, Iowa, on land owned by Charles Kroon, 32 feet east, 51 feet south of the northwest corner of the northeast quarter of the northeast quarter of section 32, T. 72 and N., R. 43 W., being copper bolt in B. M. stone.	163.6743	536.994
Top of cap, P. B. M. 336= ${}^{1}_{1}{}^{7}$.	....	164.8934	540.994
P. B. M. 336 A = ${}^{1}_{2}{}^{7}$.	Is about 1½ miles east of railroad bridge across Missouri River at Plattsmouth, Nebr.; is on south side of east and west road, 128 feet east and 40 feet south of northwest corner section 31, T. 72 N., R. 43 W., in dooryard of Miss Lizzie Smith, being copper bolt in B. M. stone.	164.4061	539.395
Top of cap, P. B. M. 336 A= ${}^{1}_{1}{}^{7}$.	....	165.6429	543.453
Gauge B. M., Plattsmouth.	On top of stone foundation of north end of first iron bent west of the west stone pier of the railroad bridge across Missouri River at Plattsmouth, Nebr. The B. M. is the highest part of the stone between the grooves at northeast corner of cross (+).	166.1225	545.026
P. B. M. 336 B = ${}^{1}_{1}{}^{7}$, Plattsmouth.	Is at railroad bridge across Missouri River at Plattsmouth, Nebr.; is 10 feet south, and on line with first trestle bent west of west pier, being copper bolt in B. M. stone.	164.7650	540.572
Top of cap, P. B. M. 336 B= ${}^{1}_{1}{}^{7}$.	....	166.0031	544.634
P. B. M. 327	Is 3,884 feet northward from depot at Nebraska City Junction, Fremont County, Iowa, and 45 feet east of the Kansas City, St. Joseph and Council Bluffs Ry. track on a sand knoll, being copper bolt in B. M. stone.	154.5486	507.054
Top of cap, P. B. M. 327.	....	155.7735	511.072
P. B. M. 327 A	Is about 1⅝ miles west of Nebraska City Junction, Iowa, on south side of wagon road running west from Nebraska City Junction to Burlington and Missouri River R. R. bridge across Missouri River at Nebraska City, Nebr.; is 1,150 feet east of a house on north side of road occupied by John Duncan, 3,130 feet west of where wagon road crosses Burlington and Missouri track to Payne's pasture, and 7 feet south of fence, being copper bolt in B. M. stone.	154.4311	506.668
Top of cap, P. B. M. 327 A.	....	155.6705	510.735
P. B. M. 327 B, Nebraska City, Nebr.	Is in west abutment of Burlington and Missouri River R. R. bridge across the Missouri River at Nebraska City, Nebr.; is highest part in center of circle cut in third stone from west in top course of masonry, and is marked with letters B. M. on south.	171.7515	563.494
Gauge B. M., Nebraska City, Nebr.	Is on west abutment of Burlington and Missouri River R. R. bridge across Missouri River at Nebraska City, Nebr.; is a bench cut in south side of abutment, about 2 feet above ground, near southeast corner.	161.9375	531.296
P. B. M. 318 = ${}^{1}{}^{0}_{8}{}^{6}$, Phelps, Mo.	Is at Phelps, Atchison County, Mo., in the northeast corner of the Methodist churchyard and 38 feet from the northeast corner of the church, being copper bolt in B. M. stone.	144.6591	474.608
Top of cap, P. B. M. 318= ${}^{1}{}^{0}_{3}{}^{8}$.	....	145.8836	478.625
P. B. M. 318 A = ${}^{1}{}^{0}_{2}{}^{9}$.	Is about 1 mile west from Phelps, Mo., on south side of east and west road, 780 feet west from northeast corner of SE. ¼ sec. 34, T. 65 N., R. 42 W., in dooryard of B. A. DeBuhr, being copper bolt in B. M. stone.	144.1945	473.083
Top of cap, P. B. M. 318 A= ${}^{1}{}^{0}_{2}{}^{8}$.	....	145.4364	477.158
P. B. M. 318 B = ${}^{1}{}^{0}_{1}{}^{0}$.	Is at Brownville, Nebr., at northwest corner of Main street and levee, and 122 feet northwest from depot, being copper bolt in B. M. stone.	149.9484	491.961
Top of cap, P. B. M. 318 B= ${}^{1}{}^{0}_{1}{}^{0}$.	....	151.1884	496.029
P. B. M. 304	Is 627 feet southward from the depot at Napier, Holt County, Mo., 287 feet southward from the head block of the Burlington and Missouri River and the Kansas City, St. Joseph and Council Bluffs Ry. Junction, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Ry. track, being copper bolt in B. M. stone.	132.1619	433.606

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
Top of cap, P. B. M. 304.	....	133.3943	437.649
P. B. M. 304 A	Is about 650 feet east of the depot at Fortescue, Mo., 59 feet north of center of main track of Burlington and Missouri River R. R., and 39 feet west from west end of section house, being copper bolt in B. M. stone.	134.5626	441.482
Top of cap, P. B. M. 304 A.	....	135.8033	445.553
P. B. M. 304 B	Is about 10,830 feet west from Fortescue, Mo., 66 feet north of Burlington and Missouri River R. R. track, 650 feet west of south end of Tarkio Lake, and 23 feet east of a 16-inch blazed cottonwood on land belonging to Collins, being copper bolt in B. M. stone.	132.4888	434.678
Top of cap, P. B. M. 304 B.	....	133.7246	438.733
P. B. M. 304 C = Ψ ...	Is 7,600 feet east from east pier of Burlington and Missouri River R. R. bridge across the Missouri River at Rulo, Nebr., 400 feet north of Burlington and Missouri River track center, 20 feet west of north and south road, which crosses the line of Burlington and Missouri River R. R. under the first bridge east from river, 82 feet northeast from small log house occupied by K. Burge and on land owned by Ben Cunningham, in southeast corner of cultivated field and 2 feet from corner post of fence, being copper bolt in B. M. stone.	134.9474	442.745
Top of cap, P. B. M. 304 C = Ψ.	....	136.1827	446.798
P. B. M. 304 D	Is in west pier of Burlington and Missouri River R. R. bridge across Missouri River at Rulo, Nebr. Is center of hole in horizontal bolt leaded into west side of granite pier, in second course of masonry above ground, and in fourth block from north end, and in third block from south end of pier. Is 0.3 foot below top of block and 1.8 feet from south end, and 1.5 feet from north end. Is marked U. S. ⊙ B. M.	137.2540	450.312
Gauge B. M., Rulo, Nebr.	Is in west face of a granite block in the west side of the west pier of Burlington and Missouri River R. R. bridge at Rulo, Nebr. The block is in second course of masonry from ground, and is the first straight block from the south end of pier (the block south being rounded). The bench is a projection flattened on upper side, and is 1.7 feet from north end of block and 0.4 foot below top of block.	136.6057	448.185
P. B. M. 304 E = Ψ ..	Is at Rulo, Nebr., in dooryard of John Stull, at west side of Commercial street, and 170 feet south from south line of Stutzen street. Is copper bolt in B. M. stone.	135.8055	445.560
Top of cap, P. B. M. 304 E = Ψ.	....	137.0402	449.611
P. B. M. 228 = Ψ	Is on right bank about 3½ miles below Hannibal and St. Joseph R. R. bridge across Missouri River at Kansas City, Mo., five-eighths of a mile southeast of Crescent elevator, about 2,295 feet north of tile factory, at northeast corner of intersection of two county roads, 120 feet S. 65° W. of Lizzie Wright's house; being copper bolt in B. M. stone.	97.8868	321.154
Top of cap, P. B. M. 228 = Ψ.	....	99.1279	325.226
P. B. M. 228 A	Is on west end of north pier of Chicago, Milwaukee and St. Paul R. R. bridge across Missouri River near Kansas City, Mo. Is center of square cut in cap stone, 1.1 feet west of west iron girder of approach, and 1.5 feet south from north edge of pier. The letters B. M. are cut in the stone south of square.	114.9573	377.160
P. B. M. 228 B = Ψ ...	Is on left bank 970 feet above Chicago, Milwaukee and St. Paul R. R. bridge across the Missouri River near Kansas City, Mo., and 25 feet toward river from Wabash track. Is copper bolt in B. M. stone.	101.8795	334.253
Top of cap, P. B. M. 228 B = Ψ.	....	103.1199	338.323
P. B. M. 171 = Ψ	Is opposite De Witt, Mo., on line running east and west through center of section 22, T. 53, R. 21 W., 60 feet west of quarter post between sections 22 and 23, about 820 feet west of S. W. Wood's house at south road fence; being copper bolt in B. M. stone.	67.7800	222.377
Top of cap, P. M. B. 171 = Ψ.	....	69.0162	226.433
P. B. M. 171 A. = Ψ ..	Is on right bank, opposite De Witt, Mo., and about one-half of a mile from Missouri River. Is on east side of north and south road between sections 15 and 16, and 470 feet north from southwest corner of section 15; being copper bolt in B. M. stone.	67.7440	222.259

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number	Description.	Elevation.	
		Meters.	Feet.
Top of cap, P. B. M. 171 A=$\frac{52}{2}$.	....	68.9843	226.328
P. B. M. 171 B.=$\frac{52}{3}$..	Is in De Witt, Mo., at foot of bluff, 350 feet west from Wabash depot, 55 feet south from center of Jefferson street, in corner of lot owned by W. M. Rogers. Is copper bolt in B. M. stone.	71.5594	234.777
Top of cap, P. B. M. 171 B=$\frac{52}{3}$.	....	72.7984	238.842
Gauge B. M., De Witt, Mo.	Is nail in root on west side of a double locust about 2 feet in diameter, 50 feet from river bank, and 50 feet from warehouse on side nearest river, about 560 feet down river from depot at De Witt, Mo.	70.5865	231.585

TABULATION OF PRECISE LEVEL RESULTS, BLAIR, NEBR., TO DE WITT, MO., 1893.

In the table of results column 1 gives the bench mark, T. B. M., signifying temporary bench mark, and P. B. M , signifying precise level bench mark.

Column 2 gives the bench mark from which that in column 1 was determined.

Column 3 gives the length of stretch in meters.

Column 4 gives the distance in kilometers from initial bench mark.

Column 5 gives the direction in which the line was leveled. Dir. is for the direct line. Rev. is for the reverse line.

Column 6 gives successive differences of elevation in millimeters between bench marks and the means of such determinations.

Column 7 gives the residuals found by substracting each determination from the mean.

Column 8 gives the discrepancy between the direct line and the mean, and is the algebraic sum of the residuals.

Column 9 gives the discrepancy between the reverse line and the mean, and is the algebraic sum of the residuals.

Column 10 gives the probable error, *r*, of the mean in column 5.

Column 11 gives the probable error, R, of the mean elevation of each bench mark as computed from the beginning of the section.

Column 12 gives the total rod correction as computed from initial bench mark (not used).

Column 13 gives the elevation in meters of all bench marks referred to St. Louis directrix.

Column 14 gives the elevation in feet of all bench marks referred to St. Louis directrix.

Column 15 gives the elevation in feet of all old bench marks connected with referred to St. Louis directrix.

Column 16 gives the discrepancy in feet of old bench marks.

Column 17 gives the initial of observers; T. is for Assistant Engineer O. H. B. Turner.

Bench marks marked with an asterisk (*) are not in the main line.

The value of the meter used is 3.2808693 feet.

P. B. M. 336 = 1/5 7 .... T. B. M. 11	P. B. M. 336 = 1/5 7	26	0.026	Rev ..	+ 821.3	0.0	0.0	0.0	0.0	0.0	....	163.0743	536.904	....	....	T.
				Dir ...	+ 821.3	0.0						164.4056	539.680	....	....	
				Mean.	+ 821.3											
* Cap. P. B. M. 336 = 1/3 7.	T. B. M. 11	26	....	Rev ..	+ 397.7	+ 0.1	....	....	0.1	0.1	....	164.8934	540.994	....	....	T.
				Dir ...	+398.0	− 0.2										
				Mean.	+ 397.8											
T. B. M. 12	T. B. M. 11	876	0.902	Rev ..	+ 128.6	− 1.1	+ 1.1	− 1.1	0.7	0.7	....	164.6231	540.107	....	....	T.
				Dir ...	+ 126.4	+ 1.1										
				Mean.	+ 127.5											
T. B. M. 13	T. B. M. 12	712	1.614	Rev ..	− 316.7	− 0.1	+ 1.3	− 1.2	0.1	0.7	....	164.3063	539.067	....	....	T.
				Dir ...	− 317.0	+ 0.2										
				Mean ..	− 316.8											
T. B. M. 14	T. B. M. 13	1,114	2.728	Rev ..	+ 1,541.0	0.0	+ 1.3	− 1.2	0.0	0.7	....	165.8473	544.123	....	....	T.
				Dir ...	+ 1,541.0	0.0										
				Mean.	+ 1,541.0											
P. B. M. 336 A = 1/2 7 ...	T. B. M. 14	26	....	Dir ...	− 1,441.0	− 0.2	....	....	0.1	0.7	....	164.4061	539.395	538.794	−0.601	T.
				Rev ..	− 1,441.3	+ 0.1										
				Mean.	−1,441.2											
*Cap. P. B. M. 336 A' = 1/2 7	T. B. M. 14	26	....	Dir ...	− 204.4	0.0	....	....	0.0	0.7	....	165.6429	543.453	....	....	T.
				Rev...	− 204.4	0.0										
				Mean.	− 204.4											
T. B. M. 15	T. B. M. 14	1,222	3.950	Rev ..	− 251.3	+ 1.0	+ 0.3	− 0.2	0.7	1.0	....	165.5970	543.302	....	....	T.
				Dir ...	− 249.3	− 1.0										
				Mean.	− 250.3											
T. B. M. 16	T. B. M. 15	538	4.488	Rev ..	+ 754.7	− 0.7	+ 1.0	− 0.9	0.5	1.1	....	166.3510	545.776	....	....	T.
				Dir. ..	+ 753.3	+ 0.7										
				Mean.	+ 754.0											
T. B. M. 17	T. B. M. 16	154	4.642	Dir ...	+12,671.5	− 0.4	+ 0.6	− 0.5	0.3	1.1	....	179.0221	587.348	....	....	T.
				Rev...	+12,670.7	+ 0.4										
				Mean.	+12,671.1											

Tabulation of precise level results, Blair, Nebr., to De Witt, Mo., 1893—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V. Direct line.	Σ V. Reverse line.	r.	R.	Rod correction.	Elevation above St. Louis City directrix. Meters.	Elevation above St. Louis City directrix. Feet.	Elevation above St. Louis City directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
* Cap. P. B. M. 360 A	T. B. M. 6	17	....	Rev	+ 830.5	+ 0.1	....	....	0.1	1.4	....	181.9554	596.972	....	....	T.
				Dir	+ 830.8	− 0.2										
				Mean	+ 830.6											
T. B. M. 7	T. B. M. 6	660	5.383	Rev	+ 1,104.3	− 1.1	− 0.2	+ 0.2	0.8	1.6	....	182.2280	597.866	....	....	T.
				Dir	+ 1,102.0	+ 1.2										
				Mean	+ 1,103.2											
T. B. M. 8	T. B. M. 7	868	6.251	Rev	− 637.7	− 0.1	....	+ 0.1	0.1	1.6	....	181.5902	595.774	....	....	T.
				Dir	− 638.0	+ 0.2										
				Mean	− 637.8											
T. B. M. 9	T. B. M. 8	1,079	7.330	Rev	+ 5,548.7	− 1.3	+ 1.4	− 1.2	0.9	1.8	....	187.1376	613.974	....	....	T.
				Dir	+ 5,546.0	+ 1.4										
				Mean	+ 5,547.4											
T. B. M. 10	T. B. M. 9	984	8.314	Rev	+ 8,786.7	− 0.2	+ 1.6	− 1.4	0.1	1.8	....	195.9241	642.801	....	....	T.
				Dir	+ 8,786.3	+ 0.2										
				Mean	+ 8,786.5											
P. B. M. 360 B = B. M.	T. B. M. 10	470	8.784	Dir	− 1,606.8	− 1.0	+ 0.6	− 0.3	0.7	2.0	....	194.2163	637.526	....	....	T.
				Rev	− 1,608.9	+ 1.1										
				Mean	− 1,607.8											
* P. B. M. 360 C = ½'	P. B. M. 360 B	25	....	Dir	− 4.3	− 0.2	....	....	0.1	2.0	....	194.3118	637.512	636.238	−1.274	T.
				Rev	− 4.7	+ 0.2										
				Mean	− 4.5											
Gauge B. M. Blair, Nebr.	P. B. M. 360 B	312	9.096	Dir	−13,063.8	− 0.8	− 0.2	+ 0.5	0.5	2.0	....	181.2517	594.663	594.177	−0.486	T.
				Rev	−13,065.4	+ 0.8										
				Mean	−13,064.6											

P. B. M. 336 = 1½7	....	....	....	....	....	....	....	....	....	....	....	163. 0743	536. 004	....	....	
T. B. M. 11	P. B. M. 336 = 1½7 .	20	0. 020	Rev ...	+ 821. 3	0. 0	0. 0	0. 0	0. 0	0. 0	....	164. 4956	539. 689	....	....	T.
				Dir ...	+ 821. 3	0. 0										
				Mean.	+ 821. 3											
* Cap. P. B. M. 336 = 1½7.	T. B. M. 11	23	....	Rev ..	+ 397. 7	+ 0. 1	....	....	0. 1	0. 1	....	164. 8934	540. 994	....	....	T.
				Dir ...	+ 398. 0	− 0. 2										
				Mean.	+ 397. 8											
T. B. M. 12	T. B. M. 11	876	0. 902	Rev ..	+ 128. 6	− 1. 1	+ 1. 1	− 1. 1	0. 7	0. 7	....	164. 6231	540. 107	....	....	T.
				Dir ...	+ 126. 4	+ 1. 1										
				Mean.	+ 127. 5											
T. B. M. 13	T. B. M. 12	712	1. 614	Rev ..	− 316. 7	− 0. 1	+ 1. 3	− 1. 2	0. 1	0. 7	....	164. 3063	539. 067	....	....	T.
				Dir ...	− 317. 0	+ 0. 2										
				Mean ..	− 316. 8											
T. B. M. 14	T. B. M. 13	1, 114	2. 728	Rev ..	+ 1, 541. 0	0. 0	+ 1. 3	− 1. 2	0. 0	0. 7	....	165. 8473	544. 123	....	....	T.
				Dir ...	+ 1, 541. 0	0. 0										
				Mean.	+ 1, 541. 0											
* P. B. M. 336 A = 1½7 ...	T. B. M. 14	26	....	Dir ...	− 1, 441. 0	− 0. 2	....	....	0. 1	0. 7	....	164. 4061	539. 395	538. 794	−0. 601	T.
				Rev ..	− 1, 441. 3	+ 0. 1										
				Mean.	−1, 441. 2											
*Cap. P. B. M. 336 A¹ = 1½7	T. B. M. 14	26	....	Dir ...	− 204. 4	0. 0	....	....	0. 0	0. 7	....	165. 6429	543. 453	....	....	T.
				Rev...	− 204. 4	0. 0										
				Mean .	− 204. 4											
T. B. M. 15	T. B. M. 14	1, 222	3. 950	Rev ..	− 251. 3	+ 1. 0	+ 0. 3	− 0. 2	0. 7	1. 0	....	165. 5970	543. 302	....	....	T.
				Dir ...	− 249. 3	− 1. 0										
				Mean .	− 250. 3											
T. B. M. 16	T. B. M. 15	538	4. 488	Rev ..	+ 754. 7	− 0. 7	+ 1. 0	− 0. 9	0. 5	1. 1	....	166. 3510	545. 776	....	....	T.
				Dir. ..	+ 753. 3	+ 0. 7										
				Mean .	+ 754. 0											
T. B. M. 17	T. B. M. 16	154	4. 642	Dir ...	+12, 671. 5	− 0. 4	+ 0. 6	− 0. 5	0. 3	1. 1	....	179. 0221	587. 348	....	....	T.
				Rev...	+12, 670. 7	+ 0. 4										
				Mean .	+12, 671. 1											

Tabulation of precise level results, Blair, Nebr., to De Witt, Mo., 1893—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals V	ΣV Direct line.	ΣV Reverse line.	r.	R.	Rod correction.	Elevation above St. Louis City directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 18	T. B. M. 17	922	5.564	Dir	+ 2,311.0	+ 0.8	+ 1.4	− 1.4	0.6	1.3	....	181.3339	594.933	....	....	T.
				Rev	+ 2,312.7	− 0.9										
				Mean	+ 2,311.8											
Gauge B. M. Plattsmouth, Nebr.	T. B. M. 18	124	5.688	Dir	−15,211.8	+ 0.4	+ 1.8	− 1.7	0.2	1.3	....	166.1225	545.026	544.480	−0.546	T.
				Rev	−15,211.1	− 0.3										
				Mean	−15,211.4											
P. B. M. 336 B = $\frac{117}{1}$ Plattsmouth.	Gauge B. M	30	5.718	Dir	− 1,357.5	0.0	+ 1.8	− 1.7	0.0	1.3	....	164.7650	540.572	540.020	−0.552	T.
				Rev	− 1,357.5	0.0										
				Mean	− 1,357.5											
* Cap. P. B M. 336 B = $\frac{117}{1}$	Gauge B. M	30	....	Dir	− 119.2	− 0.2	....	....	0.1	1.3	....	166.0031	544.634	....	....	T.
				Rev	− 119.5	+ 0.1										
				Mean	− 119.4											
P. B. M. 327											....	154.5486	507.054	....	....	
T. B. M. 19	P. B. M. 327	19	0.019	Dir	+ 470.3	+0.1	+ 0.1	− 0.2	0.1	0.1	....	155.0190	508.597	....	....	T.
				Rev	+ 470.6	−0.2										
				Mean	+ 470.4											
* Cap. P. B. M. 327	T. B. M. 19	19	....	Rev	+ 754.3	+0.2	....	....	0.1	0.1	....	155.7735	511.072	....	....	T.
				Dir	+ 754.7	−0.2										
				Mean	+ 754.5											
T. B. M. 20	T. B. M. 19	760	0.779	Rev	− 1,156.7	+1.2	− 1.1	+ 1.0	0.8	0.8	....	153.8635	504.806	....	....	T.
				Dir	− 1,154.3	−1.2										
				Mean	− 1,155.5											
T. B. M. 21	T. B. M. 20	790	1.569	Rev	+ 1,346.3	−1.5	+ 0.4	− 0.5	1.0	1.3	....	155.2083	509.218	....	....	T.
				Dir	+ 1,343.3	+1.5										
				Mean	+ 1,344.8											

T. B. M. 22	T. B. M. 21	1,120	2.080	Rev ...	+ 249.1	+ 0.5	— 0.1	0.0	0.3	1.3	....	155.4579	510.037	....	....	T.
				Dir ...	+ 250.1	— 0.5										
				Mean .	+ 249.6											
* P. B. M. 327 A	T. B. M. 22	22	....	Rev ...	— 1,026.6	—0.2	....	....	0.1	1.3	....	154.4311	506.068	....	....	T.
				Dir ...	— 1,026.9	+0.1										
				Mean .	— 1,026.8											
* Cap. P. B. M. 327 A ..	T. B. M. 22	22	....	Rev ...	+ 212.4	+ 0.2	....	....	0.1	1.3	....	155.6705	510.735	....	....	T.
				Dir ...	+ 212.7	— 0.1										
				Mean .	+ 212.6											
T. B. M. 23	T. B. M. 22	1,032	3.721	Rev ...	+ 545.0	— 1.6	+ 1.4	— 1.6	1.0	1.7	....	156.0013	511.820	....	....	T.
				Dir ...	+ 541.9	+ 1.5										
				Mean .	+ 543.4											
T. B. M. 24	T. B. M. 23	1,104	4.825	Rev ...	— 1,679.3	— 1.1	+ 2.6	— 2.7	0.8	1.8	....	154.3209	506.307	....	....	T.
				Dir ...	— 1,681.6	+ 1.2										
				Mean .	— 1,680.4											
T. B. M. 25	T. B. M. 24	1,136	5.961	Rev ...	+ 914.7	— 0.3	+ 2.8	— 3.0	0.2	1.8	....	155.2353	509.307	....	....	T.
				Dir ...	+ 914.2	+ 0.2										
				Mean .	+ 914.4											
T. B. M. 26	T. B. M. 25	342	6.303	Dir ...	+16,576.2	+ 0.2	+ 3.0	— 3.3	0.2	1.8	....	171.8117	563.692	....	....	T.
				Rev ...	+16,576.7	— 0.3										
				Mean .	+16,576.4											
P. B. M. 327 B	T. B. M. 26	346	6.649	Rev ...	— 59.3	— 0.9	+ 3.8	— 4.2	0.6	2.0	....	171.7515	563.494	....	....	T.
				Dir ...	— 61.0	+ 0.8										
				Mean .	— 60.2											
Gauge B. M. .... Nebraska City, Nebr.	P. B. M. 327 B	282	6.931	Dir ...	— 9,813.9	— 0.1	+ 3.7	— 4.0	0.1	2.0	....	161.9375	531.296	531.238	—0.058	T.
				Rev ...	— 9,814.2	+ 0.2										
				Mean .	— 9,814.0											
P. B. M. 318 = [illegible] Phelps, Mo.	....	....	....	....	....	....	....	....	....	....	....	144.6591	474.608	....		
T. B. M. 27	P. B. M. 318 = [illegible]	20	0.020	Rev ...	+ 1,113.3	— 0.3	+ 0.4	— 0.3	0.2	0.2	....	145.7721	478.259	....	....	T.
				Dir ...	+ 1,112.6	+ 0.4										
				Mean .	+ 1,113.0											

Tabulation of precise level results, Blair, Nebr., to De Witt, Mo., 1893—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals. = V	ΣV Direct line.	ΣV Reverse line.	r.	R.	Rod correction.	Elevation above St. Louis City directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Cap P. B. M. 318 = $\frac{106}{3}$	T. B. M. 27	20	....	Dir	+ 111.7	− 0.2	....	....	0.1	0.2	....	145.8836	478.625	....	....	T.
				Rev	+ 111.3	+ 0.2										
				Mean	+ 111.5											
T. B. M. 28	T. B. M. 27	890	0.910	Dir	− 387.7	0.0	+ 0.4	− 0.3	0.0	0.2	....	145.3844	476.987	....	....	T.
				Rev	− 387.7	0.0										
				Mean	− 387.7											
T. B. M. 29	T. B. M. 28	802	1.712	Dir	+ 112.3	+ 0.2	+ 0.6	− 0.5	0.1	0.2	....	145.4969	477.356	....	....	T.
				Rev.	+ 112.7	− 0.2										
				Mean	+ 112.5											
*P. B. M. 318 A = $\frac{106}{2}$	T. B. M. 29	58	....	Dir	− 1,302.6	+ 0.2	....	....	0.1	0.2	....	144.1945	473.083	473.369	+0.286	T.
				Rev	− 1,302.3	− 0.1										
				Mean	− 1,302.4											
*Cap. P. B. M. 318 A = $\frac{106}{2}$	T. B. M. 29	58	....	Dir	− 60.3	− 0.2	....	....	0.1	0.2	....	145.4364	477.158	....	....	T.
				Rev	− 60.7	+ 0.2										
				Mean	− 60.5											
T. B. M. 30	T. B. M. 29	992	2.704	Dir	+ 497.3	− 0.7	− 0.1	+ 0.1	0.4	0.5	....	145.9935	478.986	....	....	T.
				Rev	+ 496.0	+ 0.6										
				Mean	+ 496.6											
T. B. M. 31	T. B. M. 30	1,004	3.708	Dir	+ 241.8	0.0	− 0.1	+ 0.2	0.0	0.5	....	146.2353	479.779	....	....	T.
				Rev	+ 241.7	+ 0.1										
				Mean	+ 241.8											
T. B. M. 32	T. B. M. 31	52	3.760	Rev	− 848.0	+ 0.2	− 0.2	+ 0.4	0.1	0.5	....	145.3875	476.997	....	....	T.
				Dir	− 847.7	+ 0.1										
				Mean	− 847.8											

T. B. M. 33 (River crossing Brownville.)	T. B. M. 32	702	4.522	Dir	− 349.4	......					......	145.0640	475.036	......	......	
				Dir	− 346.1	− 0.7	− 0.9	+ 1.1	0.5	0.7						
				Rev	− 299.1	+ 0.7										
				Rev	− 299.5											
				Mean	− 323.5											
T. B. M. 34	T. B. M. 33	336	4.858	Rev	+ 46.7	− 0.7	− 0.2	+ 0.4	0.5	0.8	......	145.1100	476.087	......	......	T.
				Dir	+ 45.3	+ 0.7										
				Mean	+ 46.0											
T. B. M. 35 (River crossing Brownville.)	T. B. M. 34	187	5.045	Rev	− 206.7	+ 0.3	− 0.6	+ 0.7	0.2	0.9	......	144.9036	475.410	......	......	T.
				Dir	− 206.0	− 0.4										
				Mean	− 206.4											
T. B. M. 36	T. B. M. 35	502	5.547	Dir	+ 4,537.4	+ 0.6	0.0	0.0	0.4	1.0	......	149.4416	490.298	......	......	T.
				Rev	+ 4,538.7	− 0.7										
				Mean	+ 4,538.0											
P. B. M. 318 B= $^{1}_{1}{}^{9}_{\,}{}^{6}$ Brownville, Nebr.	T. B. M. 36	15	5.562	Rev	+ 506.4	+ 0.4	− 0.3	+ 0.4	0.2	1.0	......	149.9484	491.961	492.260	+0.299	T.
				Dir	+ 507.1	− 0.3										
				Mean	+ 506.8											
*Cap. P. B. M. 318 B= $^{1}_{1}{}^{9}_{\,}{}^{6}$.	T. B. M. 36	15	......	Dir	+ 1,746.8	0.0	......	......	0.0	1.0	......	151.1884	496.029	......	......	T.
				Rev	+ 1,746.8	0.0										
				Mean	+ 1,746.8											
P. B. M. 304 Napier, Mo.	......	......	......	......	......	......	......	......	......	......	......	132.1619	433.606	......	......	
T. B. M. 37	P. B. M. 304	33	0.033	Dir	+ 1,407.1	− 0.1	− 0.1	+ 0.2	0.1	0.1	......	133.5689	438.222	......	......	T.
				Rev	+ 1,406.8	+ 0.2										
				Mean	+ 1,407.0											
*Capt. P. B. M. 304	T. B. M. 37	33	......	Rev	− 174.4	− 0.2	......	......	0.1	0.1	......	133.3943	437.649	......	......	T.
				Dir	− 174.8	+ 0.2										
				Mean	− 174.6											
T. B. M. 38	T. B. M. 37	455	0.488	Rev	+ 146.7	− 0.5	+ 0.3	− 0.3	0.3	0.3	......	133.7151	438.702	......	......	T.
				Dir	+ 145.8	+ 0.4										
				Mean	+ 146.2											

Tabulation of precise level results, Blair, Nebr., to De Witt, Mo., 1893—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V	V: Direct line.	V: Reverse line.	r.	R.	Rod correction.	Elevation above St. Louis City directrix: Meters.	Elevation above St. Louis City directrix: Feet.	Elevation above St. Louis City directrix: Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 39	T. B. M. 38	976	1.464	Rev	− 325.6	0.0	+ 0.4	− 0.3	0.0	0.3	....	133.3895	437.633	....	....	T.
				Dir	− 325.7	+ 0.1										
				Mean	− 325.6											
T. B. M. 40	T. B. M. 39	1,003	2.467	Rev	+ 1,213.5	− 1.7	+ 2.1	− 2.0	1.1	1.1	....	134.6013	441.609	....	....	T.
				Dir	+ 1,210.1	+ 1.7										
				Mean	+ 1,211.8											
T. B. M. 41	T. B. M. 40	830	3.297	Dir	+ 77.0	0.0	+ 2.1	− 2.0	0.0	1.1	....	134.6783	441.862	....	....	T.
				Rev	+ 77.0	0.0										
				Mean	+ 77.0											
T. B. M. 42	T. B. M. 41	782	4.079	Rev	+ 264.3	+ 0.2	+ 1.9	− 1.8	0.1	1.1	....	134.9428	442.730	....	....	T.
				Dir	+ 264.7	− 0.2										
				Mean	+ 264.5											
T. B. M. 43	T. B. M. 42	1,078	5.157	Rev	+ 1,216.0	− 1.0	+ 2.9	− 2.8	0.7	1.3	....	136.1578	446.716	....	....	T.
				Dir	+ 1,214.0	+ 1.0										
				Mean	+ 1,215.0											
* P. B. M. 304 A Fortescue, Mo.	T. B. M. 43	39	....	Dir	− 1,595.3	+ 0.1	....	....	0.1	1.3	....	134.5626	441.482	....	....	T.
				Rev	− 1,595.0	− 0.2										
				Mean	− 1,595.2											
* Cap. P. B. M. 304 A	T. B. M. 43	39	....	Dir	− 354.3	− 0.2	....	....	0.1	1.3	....	135.8033	445.553	....	....	T.
				Rev	− 354.7	+ 0.2										
				Mean	− 354.5											
T. B. M. 44	T. B. M. 43	364	5.521	Dir	+ 201.3	+ 0.5	+ 3.4	− 3.3	0.3	1.4	....	136.3596	447.378	....	....	T.
				Rev	+ 202.3	− 0.5										
				Mean	+ 201.8											

T. B. M. 45	T. B. M. 44	900	6.467	Dir ...	− 1,002.3	− 0.3	+ 3.1	− 2.9	0.2	1.4	....	135.3570	444.080	....	....	T.
				Rev ...	− 1,003.0	+ 0.4										
				Mean .	− 1,002.6											
T. B. M. 46	T. B. M. 45	1,102	7.580	Dir ...	+ 295.8	+ 0.6	+ 3.7	− 3.5	0.4	1.5	....	135.6534	445.061	....	....	T.
				Rev ...	+ 297.0	− 0.6										
				Mean .	+ 296.4											
T. B. M. 47	T. B. M. 46	1,068	8.657	Dir ...	− 2,335.1	+ 1.1	+ 4.8	− 4.7	0.8	1.7	....	133.3194	437.403	....	....	T.
				Rev ...	− 2,332.8	− 1.2										
				Mean .	− 2,334.0											
* P. B. M. 304 B	T. B. M. 47	16	....	Dir ...	− 831.0	+ 0.4	....	....	0.2	1.7	....	132.4888	434.678	....	....	T.
				Rev ...	− 830.3	− 0.3										
				Mean .	− 830.6											
* Cap. P. B. M. 304 B	T. B. M. 47	16	....	Dir ...	+ 405.3	− 0.1	....	....	0.1	1.7	....	133.7246	438.7[illegible]3	....	....	T.
				Rev ...	+ 405.0	+ 0.2										
				Mean .	+ 405.2											
T. B. M. 48	T. B. M. 47	772	9.429	Dir ...	+ 1,426.0	+ 1.8	+ 6.6	− 6.6	1.2	2.0	....	134.7472	442.088	....	....	T.
				Rev ...	+ 1,429.7	− 1.9										
				Mean .	+ 1,427.8											
T. B. M. 49	T. B. M. 48	934	10.363	Dir ...	+ 362.0	− 1.4	+ 5.2	− 5.3	0.9	2.2	....	135.1078	443.271	....	....	T.
				Rev ..	+ 359.3	+ 1.3										
				Mean .	+ 360.6											
T. B. M. 50	T. B. M. 49	378	10.741	Rev ..	+ 333.0	− 0.4	+ 5.5	− 5.7	0.2	2.2	....	135.4401	444.362	....	....	T.
				Dir ...	+ 332.3	+ 0.3										
				Mean .	+ 332.6											
T. B. M. 51	T. B. M. 50	880	11.621	Dir ...	+ 2,962.7	− 0.7	+ 4.8	− 5.0	0.5	2.3	....	138.4024	454.080	....	....	T.
				Rev ..	+ 2,961.3	+ 0.7										
				Mean .	+ 2,962.0											
T. B. M. 52	T. B. M. 51	233	11.854	Rev ..	− 133.7	+ 0.2	+ 4.6	− 4.8	0.1	2.3	....	138.2689	453.642	....	....	T.
				Dir ...	− 133.3	− 0.2										
				Mean .	− 133.5											

Tabulation of precise level results, Blair, Nebr., to De Witt, Mo., 1893—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V	ΣV Direct line.	ΣV Reverse line.	r.	R.	Rod correction.	Elevation above St. Louis City directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*T. B. M. 53	T. B. M. 52	150	....	Dir	− 2,398.3	− 0.2	....	....	0.1	2.3	....	135.8704	445.773	....	....	T.
				Rev	− 2,398.7	+ 0.2										
				Mean	− 2,398.5											
P. B. M. 304 C = $\frac{29}{3}$	T. B. M. 53	29	....	Dir	− 923.3	+ 0.3	....	....	0.2	2.3	....	134.9474	442.745	442.949	+0.204	T.
				Rev	− 922.6	− 0.4										
				Mean	− 923.0											
*Cap. P. B. M. = 304 C. $\frac{29}{3}$	T. B. M. 53	29	....	Dir	+ 312.3	0.0	....	....	0.0	2.3	....	136.1827	446.798	....	....	T.
				Rev	312.3	0.0										
				Mean	+ 312.3											
T. B. M. 54	T. B. M. 52	1,274	13.128	Rev	+ 7,938.0	+ 1.2	+ 3.5	− 3.6	0.8	2.4	....	146.2081	479.690	....	....	T.
				Dir	+ 7,940.3	− 1.1										
				Mean	+ 7,939.2											
T. B. M. 55	T. B. M. 54	854	13.982	Rev	+ 3,848.3	− 1.5	+ 5.0	− 5.1	1.0	2.6	....	150.0549	492.311	....	....	T.
				Dir	+ 3,845.3	+ 1.5										
				Mean	+ 3,846.8											
T. B. M. 56	T. B. M. 55	606	11.588	Rev	+ 2,425.3	+ 0.9	+ 4.2	− 4.2	0.6	2.7	....	152.4811	500.271	....	....	T.
				Dir	+ 2,427.0	− 0.8										
				Mean	+ 2,426.2											
T. B. M. 57	T. B. M. 56	165	14.753	Dir	−15,202.7	+ 0.5	+ 4.7	− 4.7	0.3	2.7	....	137.2789	450.394	....	....	T.
				Rev	−15,201.7	− 0.5										
				Mean	−15,202.2											
*Gauge B. M. Rulo, Nebr.	T. B. M. 57	36	....	Dir	− 673.0	− 0.2	....	....	0.1	2.7	....	136.6057	448.185	448.506	40.321	T.
				Rev	− 673.3	+ 0.1										
				Mean	− 673.2											

*T. B. M. 58	T. B. M. 57	10	....	Dir ...	− 566.7	+ 0.2	....	....	0.1	2.7	....	136.7114	448.535	....	....	T.
				Rev ...	− 566.3	− 0.2										
				Mean .	− 566.5											
*P. B. M. 304 D	T. B. M. 58	40	....	Dir ...	+ 541.0	+ 0.6	....	....	0.4	2.7	....	137.2540	450.312	....	....	T.
				Rev ...	+ 542.1	− 0.5										
				Mean .	+ 541.6											
T. B. M. 59	T. B. M. 57	352	15.105	Dir ...	− 573.0	− 1.0	+ 3.7	− 3.7	0.7	2.8	....	136.7049	448.511	....	....	T.
				Rev ...	− 575.0	+ 1.0										
				Mean .	− 574.0											
P. B. M, 304 E = $^{9}_{1}{}^{9}$ Rulo, Nebr.	T. B. M. 59	10	15.115	Dir ...	− 899.3	− 0.1	+ 3.6	− 3.5	0.1	2.8	....	135.8055	445.560	445.815	+0.255	T.
				Rev ...	− 899.6	+ 0.2										
				Mean .	− 899.4											
*Cap. P. B. M. 304 E = $^{9}_{1}{}^{9}$	T. B. M. 59	10	....	Dir ...	+ 335.3	0.0	....	....	0.0	2.8	....	137.0402	449.611	....	....	T.
				Rev ...	+ 335.3	0.0										
				Mean .	+ 335.3											
P. B. M. 228 = $^{7}_{1}{}^{2}$	....		....									97.8868	321.154	....	....	
T. B. M. 60	P. B. M. 228 = $^{7}_{1}{}^{2}$	25	0.025	Rev ...	+ 810.1	− 0.2	+ 0.2	− 0.2	0.1	0.1	....	98.6967	323.811	....	....	T.
				Dir ...	+ 809.7	+ 0.2										
				Mean .	+ 809.9											
*Cap. P. B. M. 228 = $^{7}_{1}{}^{2}$	T. B. M. 60	25	....	Dir ...	+ 431.2	0.0	....	....	0.0	0.1	....	99.1279	325.226	....	....	T.
				Rev ...	+ 431.2	0.0										
				Mean .	+ 431.2											
T. B. M. 61	T. B. M. 60	1,222	1.247	Rev ...	+ 3,307.3	+ 1.1	− 1.0	+ 0.9	0.8	0.8	....	102.0051	334.665	....	....	T.
				Dir ...	+ 3,309.6	− 1.2										
				Mean .	+ 3,308.4											
T. B. M. 62	T. B. M. 61	1,022	2.269	Dir ...	+ 7,437.0	+ 0.4	− 0.6	+ 0.5	0.3	0.9	....	109.4425	359.067	....	....	T.
				Rev ...	+ 7,437.8	− 0.4										
				Mean .	+ 7,437.4											
T. B. M. 63	T. B. M. 62	332	2.601	Dir ...	+ 2,830.9	+ 0.3	− 0.3	+ 0.1	0.2	0.9	....	112.2737	368.355	....	....	T.
				Rev ...	+ 2,831.6	− 0.4										
				Mean .	+ 2,831.2											

Tabulation of precise level results, Blair, Nebr., to De Witt, Mo., 1893—Continued.

Bench mark	Determined from	Length of stretch	Distance from initial point.	Direction.	Difference of elevation	Residuals V.	ΣV. Direct line	ΣV. Reverse line.	r	R.	Rod correction.	Elevation above St. Louis City directrix. Meters.	Feet.	Former by common levels.	Discrepancy	Ob.
		Meters	*Km.*		*Mm*	*Mm*	*Mm*	*Mm.*	*Mm*	*Mm*	*Mm.*				*Feet*	
P B M 228 A	T B M 63	834	3 435	Dir	+ 2,083 3	+ 0 3	0 0	− 0 3	0.2	0 9	....	114.9579	377.160	....	.. ....	T.
				Rev	+ 2,084.0	− 0 4										
				Mean	+ 2,083 6											
T. B. M 64	P B. M. 228 A	378	3.813	Dir ...	12 024 7	+ 0 1	+ 0 1	0.3	0.0	0.9	......	102 9327	337 700	....	....	T.
				Rev ..	−12 024.6	0 0										
				Mean	12 024 6											
P. B M 228 B [illegible]... Randolph bridge	T B M. 64 ..	26	3.839	Rev	1,053 0	0.2	+ 0 2	0 5	0 1	0.9	......	101.8795	334 253	334 123	−0.130	T
				Dir	1,053 3	− 0 1										
				Mean	− 1,053 2											
* Cap. P B. M 228 B [illegible]	T. B M 64	20	. .	Dir	+ 187 3	0 1	.. ..	.. ...	0 1	0 9	....	103 1199	338 323	....	....	T
				Rev	+ 187 0	+ 0 2										
				Mean	+ 187 2											
P. B. M 171 → [illegible]	.. ..	..	. ...	..	....		.. ....	....	. .	..	.	67 7800	222.377	....	.. ....	
T. B. M 65...... ...	P B. M 171 [illegible]	12	0 012	Dir	+ 938.0	+ 0.2	+ 0 2	0.1	0 1	0 1	......	68.7132	225 430	. ...	...	T.
				Rev	+ 933.3	− 0 1										
				Mean .	+ 933.2											
*Cap. P. B. M 171 [illegible] ..	T. B. M. 65	12	....	Rev...	+ 303.0	0.0	.. ...	....	0.0	0 1	....	69.0163	226.433	....	.. ...	T.
				Dir ...	+ 303.0	0.0										
				Mean .	+ 303.0											
T B. M 66	T. B M. 65	639	0.651	Rev ..	+ 862.0	+ 0.4	− 0.1	+ 0.3	0.2	0.2	....	69.5756	228.268	....	....	T.
				Dir ...	+ 862.7	− 0.3										
				Mean .	+ 862.4											
T. B. M. 67	T. B M. 66	900	1.551	Rev ..	+ 611.0	+ 1.4	− 1.4	+ 1.7	0.9	0.9	....	70.1880	230.277	....	....	T.
				Dir ...	+ 613.7	− 1.3										
				Mean .	+ 612.4											

	T. B. M. 330 = ¹⁄₃ᵛ	26	0.020	Rev Dir	+ 821.3 + 821.3	0.0 0.0	0.0	0.0	0.0	0.0	....	163.0743 164.4956	536.994 539.689	....	....	T.
				Mean	+ 821.3											
	B. M. 11	23	......	Rev Dir	+ 397.7 + 398.0	+ 0.1 − 0.2	.....	....	0.1	0.1	.....	164.8934	540.994	......	......	T.
				Mean	+ 397.8											
	B. M. 11	876	0.002	Rev Dir	+ 128.6 + 126.4	1.1 + 1.1	1.1	1.1	0.7	0.7	......	164.6231	540.107	......	......	T.
				Mean	127.5											
	B. M. 12	4??	1.614	Rev Dir.	− 316.7 − 317.0	− 0.1 0.2	1.3	1.2	0.1	0.7	....	164.3063	539.067	......	......	T.
				Mean	− 316.8											
	B. M. 13	1,114	2.728	Rev. Dir..	+ 1,541.0 + 1,541.0	0.0 0.0	+ 1.3	− 1.2	0.0	0.7	....	165.8473	544.123	....	....	T.
				Mean	+ 1,541.0											
	B. M. 14	26		Dir. Rev	− 1,441.0 − 1,441.3	− 0.2 + 0.1	....	.....	0.1	0.7	....	164.4001	539.395	538.794	− 0.601	T.
				Mean	− 1,441.2											
	B. M. 14	20	......	Dir Rev..	− 204.4 − 204.4	0.0 0.0	.....	......	0.0	0.7	....	165.[illegible]29	543.453	......	......	T.
				Mean	− 204.4											
	T. B. M. 14	1,222	3.950	Rev Dir.	− 251.3 − 249.3	+ 1.0 − 1.0	+ 0.3	− 0.2	0.7	1.0	....	165.5970	543.302	......	......	T.
				Mean.	− 250.3											
T. B. M. 16	T. B. M. 15	538	4.488	Rev. Dir.	+ 754.7 + 753.3	− 0.7 + 0.7	+ 1.0	− 0.9	0.5	1.1	......	166.3510	545.776	......	......	T.
				Mean	+ 754.0											
T. B. M. 17	T. B. M. 16	154	4.642	Dir Rev.	+ 12,671.5 + 12,670.7	− 0.4 + 0.4	+ 0.0	− 0.5	0.3	1.1	......	179.0221	587.348	....	....	T.
				Mean	+ 12,671.1											

APPENDIX A 3.

REPORT ON MEASUREMENT OF BRIDGES, 1894.

Lowest points of superstructure of bridges over the Missouri River completed since June 30, 1893.

All elevations are above St. Louis directrix according to the precise levels of 1892. T. B. M. = temporary bench mark of precise level survey. "Bench marks to which referred" are reduced to precise level elevations.]

Bridge at—	Date of measurement.	Number of through spans.	Spans numbered, from which end.	Channel span number.	Lowest point of superstructure.	Where measured.
	1894.					
Bellefontaine Bluffs, Mo.	Mar. 13.		R. B ..	3.4	Rivet head in lateral.	Center line of bridge.
Leavenworth, Kans......	Mar. 23.	4	R. B ..	Draw 1.2	Bracing	Upstream side.

Bridge at—	First span.			Second span.		
	First panel point.	Center panel point or panel points adjacent to center.	Last panel point.	First panel point.	Center panel point or panel points adjacent to center.	Last panel point.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Bellefontaine Bluffs, Mo.	61.14	62.22	62.71	62.84	63.36	63.2[illegible]
Leavenworth, Kans	353.74	353.97 / 354.08	354.32	354.67	354.99 / 355.13	355.44

Bridge at—	Third span.			Fourth span.			Bench marks to which referred.	
	First panel point.	Center panel point or panel points adjacent to center.	Last panel point.	First panel point.	Center panel point or panel points adjacent to center.	Last panel point.	Number.	Elevation.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*		*Feet.*
Bellefontaine Bluffs, Mo ...	63.29	63.37	62.83	62.72	62.26	61.17	T. B. M. 6	17.9[illegible]
Leavenworth, Kans	355.70	355.82 / 355.82	355.66	355.46	354.79 / 354.58	353.59	T. B. M. 517	358.1[illegible]

APPENDIX A 4.

ANNUAL REPORT OF A. H. BLAISDELL, ASSISTANT ENGINEER, 1894.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1894.

SIR: I have the honor to submit the following report on the water gauges maintained by the Missouri River Commission during the fiscal year ending June 30, 1894.

The accompanying table gives the location of each gauge in miles above the mouth of the river and the time it was maintained during the year.

The distances below Sioux City, Iowa, are measured on the low-water channel line of the Missouri River Commission maps of 1890, and that to the upper river gauge at Townsend, from the various maps of surveys made by the Commission and by Capts. Hodges, Powell, and Maguire, Corps of Engineers, U. S. A., between 1889 and 1892, inclusive.

The Missouri River Commission at the end of the year maintains twenty-three permanent and two temporary gauges; the latter being read in connection with the works in progress on the First Reach, at Ewings Landing and Gasconade, Mo.

The Weather Bureau gauge at Hermann was also read during a portion of the year, before the removal of the office of Division Engineer S. Waters Fox to Gasconade.

MISSO MISSION.

OVERIVER

BEIOWA.

completed June 30, 1894.

100 0 900 Feet

00 Feet

L.P.S. nerstructure.

All elevalevels of 1892,

and nDirectrix.

To ad for 1894.

ngineers.

mmission.

Lowest p

All eleva
porary
cise lev

B

Bellefo

Leaven

Bri

Bell
Bl
Lea
K

Location of gauge.	Character of gauge.	Miles above mouth.	Months maintained during year.
Bellefontaine bridge, Missouri	Bridge cable	8 2	$3\frac{18}{30}$
St. Charles, Mo	do	28.06	12
Hermann, Mo	Weather Bureau shore inclined	103.3	$7\frac{1}{3}$
Cole Creek, Mo	Shore, inclined	107.1	12
Gasconade, Mo	do	110.4	$7\frac{1}{6}$
Ewings Landing, Mo	Shore, cable	143.8	12
Jefferson City, Mo	Shore, inclined	151.3	12
Boonville, Mo	Bridge cable	205.8	12
Glasgow, Mo	do	237.5	12
Dewitt, Mo	Shore, cable and inclined	267.2	12
Waverly, Mo	Shore, inclined	299.1	12
Lexington, Mo	do	322	12
Sibley, Mo	Bridge cable	350	12
Randolph, Mo	do	386.7	$11\frac{28}{30}$
Kansas City, Mo	do	390.7	12
Fort Leavenworth bridge, Kansas	do	424	12
Atchison, Kans	do	447.8	12
St. Joseph, Mo	do	479	12
Rulo, Nebr	do	537.5	12
Brownville, Nebr	Shore, cable and inclined	577.6	12
Nebraska City, Nebr	Bridge, cable	607.7	12
Plattsmouth bridge, Nebraska	do	633.6	12
Omaha, Nebr	do	659.1	12
Blair, Nebr	do	694.6	12
Sioux City bridge, Iowa	do	805.7	12
Townsend, Mont	do	2,504	12

The inspection of the gauges has been in charge of Mr. L. P. Butler, assistant engineer, who has made three complete tours of inspection between the mouth and Sioux City during the year, one in September, 1893, one in November-December, 1893, and one in May-June, 1894; in addition to the work connected directly with the gauges he has made measurements of two bridges, completed during the year, conducted two special surveys, and aided in the gathering of commercial statistics.

The gauges at the present time are all in good condition, and only two entire renewals—at Dewitt, Mo., and Brownville, Nebr.,—were necessary during the year.

A new permanent gauge was established March 13, 1894, on Bellefontaine bridge. All the other gauges have been kept in good repair at slight expense.

Level connections between the gauge bench marks and those of the precise level lines having been completed, the graduations on all the gauges were made to read precise level elevations above the St. Louis directrix during the November-December inspection.

The pilot bulletin service for 1893 was discontinued on November 30, except for the Kansas City station, where it was made continuous at the request of local steamboat owners.

The service for 1894 was resumed on March 16 at the permanent gauge stations between St. Charles and Kansas City, and on April 16 an additional bulletin was displayed on the new Bellefontaine bridge, for which two of the larger size of frames had been provided. A slight change was made in the design of the bulletin frames for the Bellefontaine bridge at the instance of Mr. George S. Morison, chief engineer, which better adapted them for attachment to the bridge.

During the year 1893 the bulletins read from a stage 5.1 feet below a mean stage of the navigable low waters at each station, this stage having been taken in order that the Missouri River Commission bulletin readings should agree with the daily published records of the Weather Bureau at Kansas City. After the gauges were changed to read precise level elevations it was found that the equating number at Kansas City required a change to 5 feet, and accordingly all the bulletins except at Randolph bridge now read from a zero which is 5 feet below a mean of observed navigable low water, as near as the data at hand allows the mean to be determined.

The exception noted at Randolph bridge appeared to be necessary, as its bulletin record of the year 1893 would sometimes show a higher stage on the same day than at Kansas City, 4 miles above; this may be accounted for by the change in slope between the two stations resulting from works of channel rectification and by an insufficient number of subsequent low-water gauge heights.

The pilot bulletins are now exhibiting one daily reading in accordance with the 6 a. m. stage from zeros as follows:

Locality	Elevation of pilot bulletin zeros, referred to St. Louis directrix.	Remarks.
Kansas City	303.5	Elevation of Weather Bureau zero, 303.47.
Randolph bridge	301.0	
Sibley bridge	271.4	
Lexington	250.0	
Waverly	230.6	
Dewitt	203.2	
Glasgow bridge	176.2	
Boonville	152.2	Elevation of Weather Bureau zero, 152.33.
Jefferson City	108.7	
Cole Creek	70.6	
St. Charles bridge	2.7	
Bellefontaine bridge	—13.2	

The zero elevation of the Weather Bureau gauge at Hermann is at present 71.23; but this value only holds good up to the 13-foot mark, above which the gauge is wrongly graduated, each foot recorded being actually equal to about 0.876.

According to the rule adopted by the Commission the Hermann gauge should read from a zero of 68.35. The zero of this gauge has not been kept constant, having been as low as 67.34 previous to 1886, when it was changed to its present elevation.

In connection with the determination of the mean navigable low waters, some study has been made, since the precise levels have been available, in an endeavor to trace a law connecting length of river with mean gauge heights.

The investigation has not yet been completed, but it has been carried far enough to show that, using the average distances above the mouth as measured on the low-water channel lines from the maps of 1878–'79 and 1890 as abscissa (x), the height of the mean navigable low water in that portion of the river from a point above the mouth of Osage River to Rulo, Nebr., may be determined closely by the equation of the straight line $y=0.812x-7$. The mean high water, for the same portion of the river may be approximately expressed by a similar formula of $y=0.812x+7.4$ at all the stations except where there are large tributary streams, at which points a further addition of about 2.7 feet becomes necessary to the gauge heights.

On the portion of the river above Rulo no formula appears to be applicable, and on the lower portion the slope appears to increase and the formula changes. The gauge stations are quite far apart on these portions of the river, and perhaps with more data further study may reveal a practical result to an investigation which at present is only in a preliminary stage.

The bulletins, in addition to showing the daily stage of the river, also serve to give the available heights under bridges for passing steamboats, and cards explanatory of the service with a table for ascertaining this height from the bulletin reading have been issued to all steamboatmen interested.

The results of the precise levels have shown that all the stages published by the Missouri River Commission are more or less in error. These published stages are comprised in two pamphlets; one issued in 1886, entitled "Stages of the Missouri River from St. Charles to Fort Pierre, Dak., between 1872 and 1885," which was also published as Appendix A 6 of the annual report of the Missouri River Commission for the year ending June 30, 1886, and one pamphlet issued in 1890, entitled "Stages of the Missouri River from St. Charles, Mo., to Sioux City, Iowa, 1886 to 1889, both inclusive."

The following table gives the correction to be applied algebraically to each of the published records to reduce them to the precise level elevations:

Locality.	Corrections. First pamphlet, 1872-1885.	Corrections. Second pamphlet, 1886-1889.
Jamestown Landing, Mo	+0.347	....
St. Charles bridge, Missouri	+0.382	+0.082
Washington, Mo	+0.420	....
Hermann, Mo	+0.435	+0.135
Jefferson City, Mo	+0.534	+0.206
Boonville bridge, Missouri	+0.523	+0.223
Glasgow bridge, Missouri	+0.582	+0.254
Dewitt, Mo	+1.594	+1.294
Miami, Mo	+0.594	....
Waverly, Mo	+0.552	+0.252

Locality.	Corrections.	
	First pamphlet, 1872-1885.	Second pamphlet, 1886-1889.
Lexington, Mo	+0.315	+0.015
Sibley bridge, Missouri		+0.143
Randolph bridge, Missouri		+0.130
Kansas City, Mo. (Hannibal and St. Joseph bridge)	+0.522	+0.222
Leavenworth, Kans	+0.394	+0.094
Fort Leavenworth bridge, Kansas		—0.070
Fort Leavenworth, Kans	+0.230	
Atchison bridge, Kansas	+0.156	—0.144
St. Joseph bridge, Missouri	+0.141	*—0.159 —0.137
St. Joseph Water Co.'s pumphouse, Missouri		—0.132
White Cloud, Kans	+0.177	—0.123
Rulo bridge, Nebraska		—0.321
Brownville, Nebr	—0.019	—0.319
Nebraska City, Nebr	+0.358	
Nebraska City bridge, Nebraska	+0.358	+0.058
Plattsmouth bridge, Nebraska	+0.846	+0.546
Plattsmouth, Nebr	+0.852	
Omaha, Nebr. (Union Pacific R. R. bridge)	+1.003	+0.703
Blair bridge, Nebraska		+0.495
Sioux City bridge, Iowa		+1.270
Sioux City, Iowa (Perry Creek)	+1.595	+1.295

* To August 26, 1889.

The manuscript of a third pamphlet in the series of Missouri River stages, embracing the four years 1890 to 1893 inclusive, is now ready for the printer. No change has been made from the methods heretofore adopted for the permanent preservation of the gauge records, as described in last year's report.

Very respectfully, your obedient servant,

A. H. Blaisdell,
Assistant Engineer.

Appendix A 5.

REPORT ON RESULTS OF ROCK BORINGS IN MISSOURI RIVER VALLEY.

Office Missouri River Commission,
St. Louis, Mo., June 30, 1894.

Sir: I have the honor to hand you herewith a report on the results of rock borings in the Missouri River Valley. The placing on record of these results was inaugurated by my predecessor, and a detailed account of them may be found in the reports of the secretaries of the Commission. (See report of Chief of Engineers for 1890, p. 3375, and for 1892, p. 3261.)

Three additional sections of the valley have been collected during the past year as follows:

A section showing the depth at which a suitable stable foundation was struck on which to base the piers of the new Leavenworth bridge; two sections of a proposed new bridge at Jefferson City, Mo.; and an approximate section in the vicinity of St. Charles, Mo., on a site of a proposed bridge.

Each locality is accompanied by a map showing the location and number of borings taken.

The drawings show the results obtained quite as fully as any extended description would do, and similar conventional signs in addition to descriptive print have been used as in former reports.

Very respectfully, your obedient servant,

James F. McIndoe,
Additional Second Lieut. of Engineers,
Secretary.

Lieut. Col. Chas. R. Suter,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

LEAVENWORTH, KANS.

Plate A.—This plate has been drawn from information furnished through the courtesy of Mr. A. J. Tullock, proprietor and engineer of the Missouri Valley Bridge and Iron Works, Leavenworth, Kans. The borings were made between January 16 and February 20, 1893, while the bridge was in course of construction.

Mr. Tullock states that in sinking Pier II "the sand was very clean and very fine, excepting where it was found with gravel. The gravel found in the caisson was very small."

In sinking the caisson for Pier IV many large logs were encountered; one log was found in sinking caisson II and none in sinking caisson III.

JEFFERSON CITY, MO.

Plate B.—This plate is a reproduction of drawings of borings taken between February 28 and March 15, 1894, obtained from Mr. J. A. L. Waddell, consulting and bridge engineer, Kansas City, Mo., by the permission of a company formed to bridge the river at this point.

The same method of making the borings was adopted as had been used at the Sibley bridge, and is fully explained in the report of the Missouri River Commission for 1890, p. 3379.

Borings were made on two crossings about 0.6 mile apart, four on each section, and were carried to bed rock in each instance.

The drawing contains all the information at hand in regard to strata passed through.

ST. CHARLES, MO.

Plate C.—This plate is also a reproduction of a drawing furnished by Mr. Waddell. The borings were made in 1892 and were not completed over the entire section on account of high water. The drawing exhibits the strata passed through in making the two borings.

APPENDIX A 6.

ANNUAL REPORT OF J. A. SEDDON, ASSISTANT ENGINEER, 1894.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1894.

SIR: I have the honor to submit the following report on the study of physical data for the fiscal year ending June 30, 1894:

The study of flood movement by the method of "extension gauge relations," completed in the Lower Mississippi, has been carried up the Missouri to Kansas City, through all the gauge records to date. While in general the movement is similar to that of the Lower Mississippi, yet there are irregularities in the Missouri which are not fully understood. It is hoped that further light will be thrown on these by the extension of the study to Sioux City, when this will be made the subject of a special report.

A preliminary study by gauge relations was made of Missouri River regimen from Kansas City down. This study of regimen is based on the idea that between two gauges all the hydraulic properties of the channel through the whole reach, from low to high water, are summed up and given graphically in the line of gauge relation; for this line gives at each point the fall between gauges for that stage, or the summation of all acting resistances to flow through the reach. A fixed change in the line of gauge relation is thus a change in regimen, and while perhaps infinitely complex in its pool and bar and section phenomena, in this summation of fall it is closely determinate and its changes readily seen in the gauge relations.

The study of regimen by gauge relations consists in the search for some order or method in these changes. In this preliminary study of the Missouri River so far no method has been seen, and it may be that it is there hopelessly complicated by independent local changes. The subject is being pursued in Lower Mississipi data, where some order has been already found in regimen and its changes, which has been embodied in several special reports not yet published.

Very respectfully, your obedient servant,

J. A. SEDDON,
Assistant Engineer.

PLATE A.

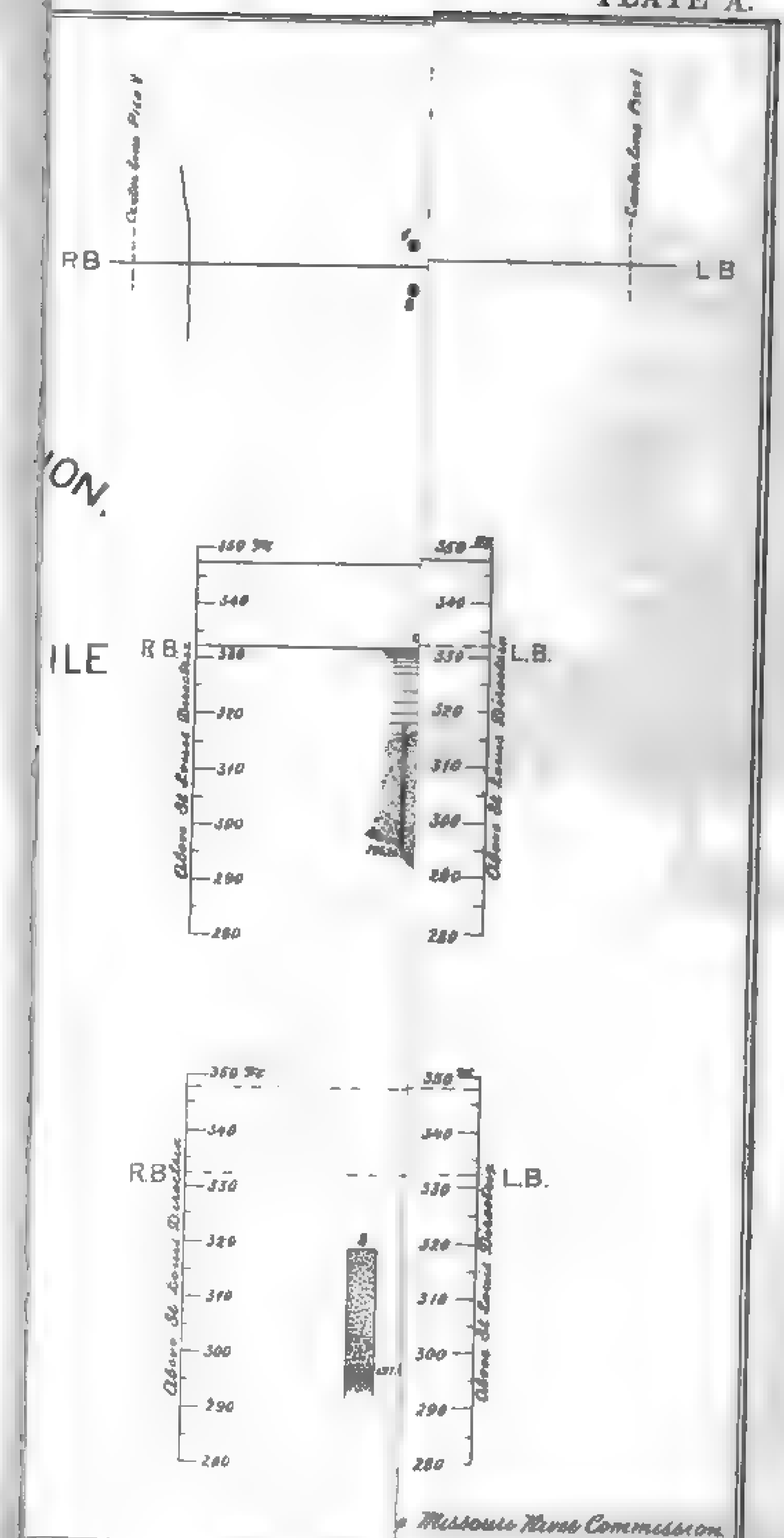
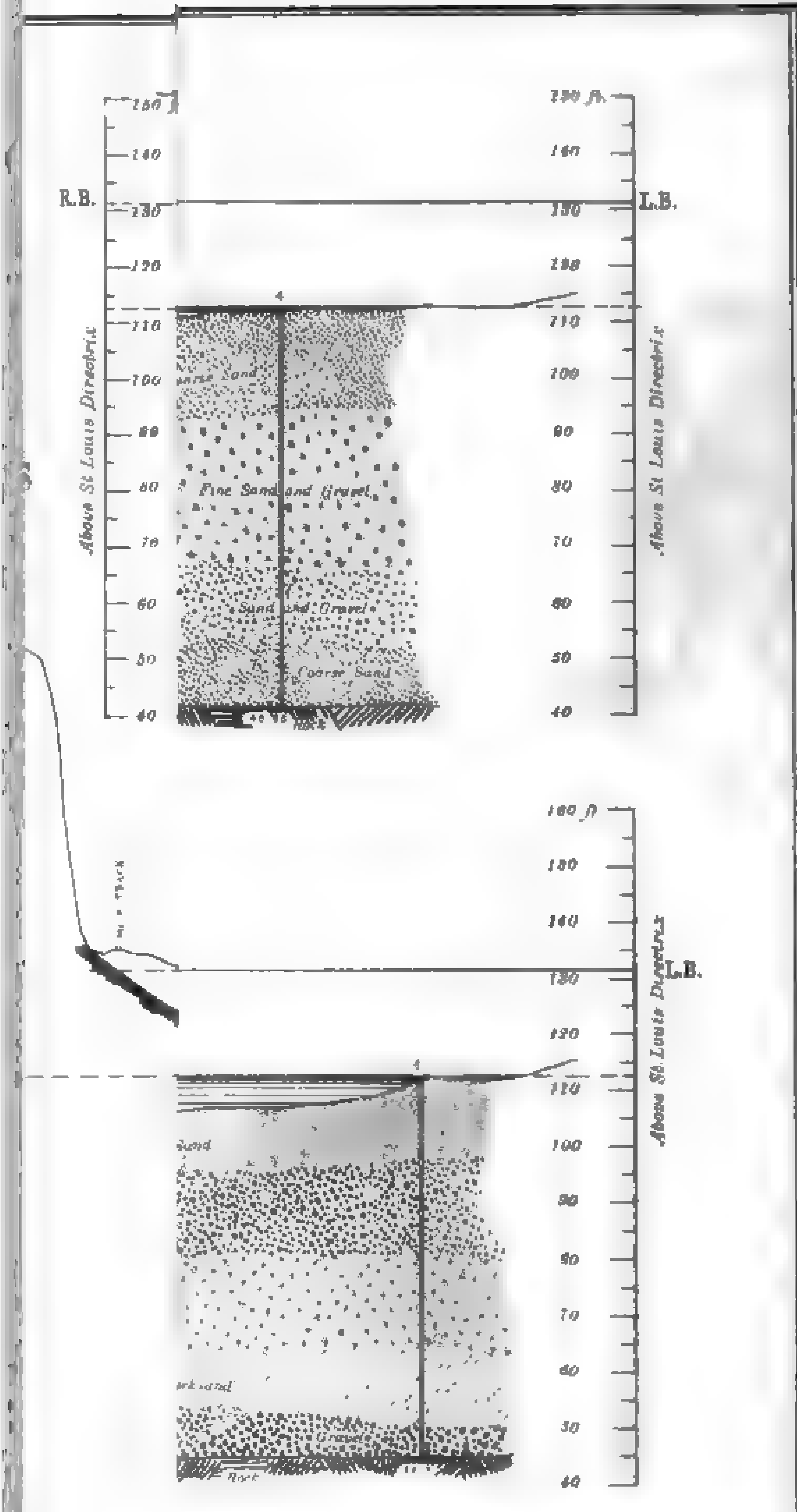
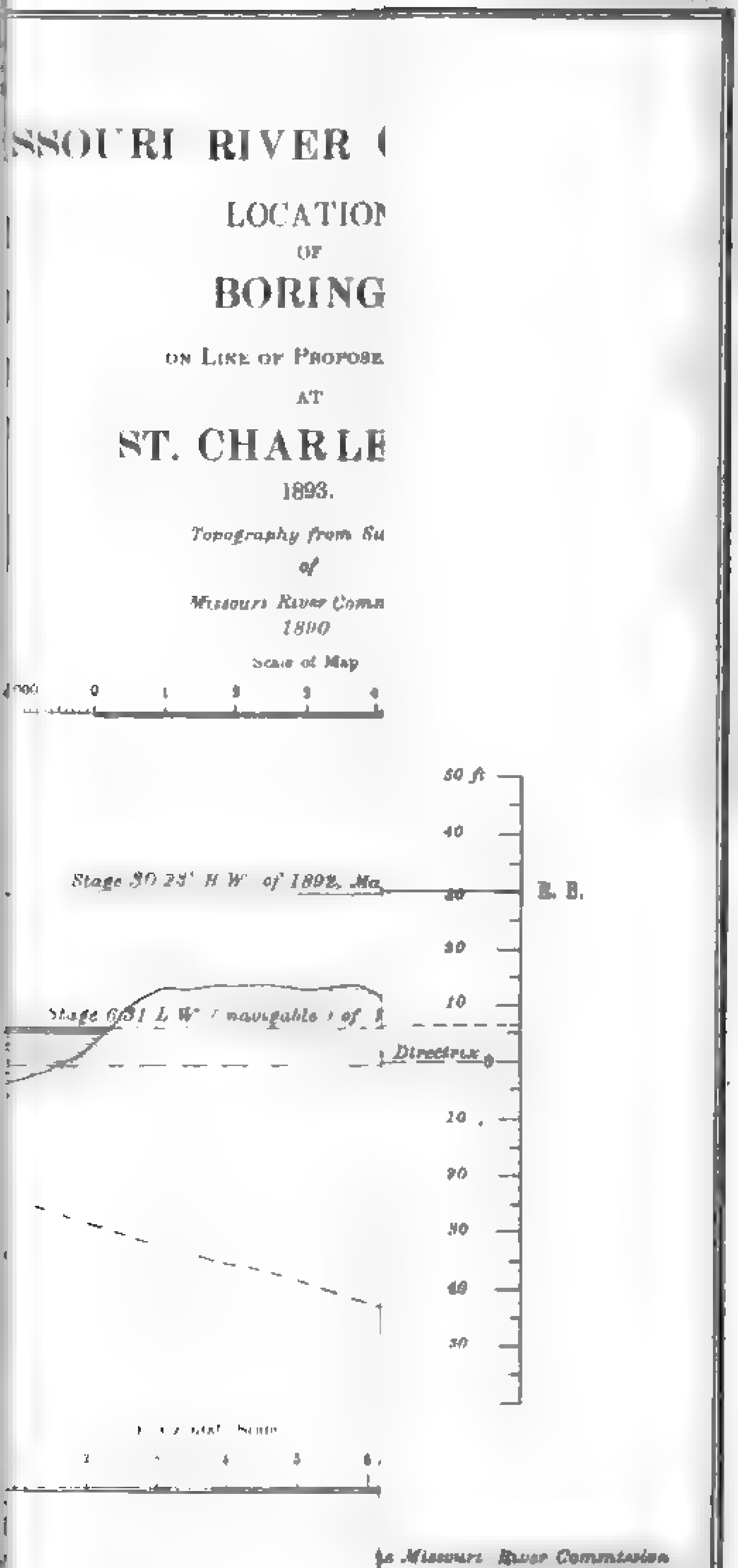

RB
LB
R.B.
L.B.
350
340
330
320
310
300
290
280
Above St Louis Direction
Missouri River Commission

PLATE B.



...t for 1891 of the Secretary of the Missouri River Commission

PLATE C.


SSOURI RIVER
LOCATION
OF
BORING
ON LINE OF PROPOSE
AT
ST. CHARLE
1893.
Topography from Su
of
Missouri River Comm
1890
Scale of Map
Stage 30.23' H W of 1892,
Stage 6.31 L W navigable of
Directrix
R. B.
50 ft
40
30
20
10
0
10
20
30
40
50
Missouri River Commission

APPENDIX A 7.

Index of surveys and physical data in annual reports Missouri River Commission from 1885 to 1893, both inclusive.

Index of surveys aad physical data in annual reports Missouri River Commission from 1885 to 1893, both inclusive—Continued.

Index of surveys and physical data in annual reports Missouri River Commission from 1885 to 1893, both inclusive—Continued.

APPENDIX A 8.

REPORT ON COMMERCE OF MISSOURI RIVER DURING CALENDAR YEAR 1893.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1894.

SIR: I have the honor to submit the following report on the commerce of the Missouri River between Sioux City (Big Sioux River) and the mouth during the calendar year 1893:

The methods employed in securing the statistics were similar to those employed last year.

The gauge observers having reported on their weekly cards all boats that passed their respective gauges; the dimensions and tonnage of all these boats were obtained from the custom-house at which they were enrolled, with the date of their last inspection.

The information thus obtained is embodied in Tables 5 to 10, inclusive.

On the 3d of February blanks covering in detail almost every article of freight carried were sent out, with an explanatory circular to the owners of various boats and also to those doing river business of any kind, except ferriage, with a request that they be filled out and returned to the secretary of the Commission.

The circular stated that only the statistics of the coasting trade and that of rafting, wood, and sand business were required.

In most cases the blanks were returned filled out as requested, but frequently further correspondence was necessary to obtain desired details. In some instances it became necessary to send an assistant to interview the owner of the boat or the proprietor of the business in order to obtain the desired information.

In the case of the long-trade packets the owners of the boats kindly sent their freight lists to the office, and from these the data contained in Table 1 was generally obtained.

The owners of some of the smaller boats either kept no books or indifferent memoranda of their trade. Of these the statistics gathered are approximate, although close, estimates.

Taking into consideration the difficulty of securing the amount of trade carried on over 811 miles of river distance, it can readily be appreciated that many minor statistics, which together would aggregate a very considerable total, must of necessity be missed, and that therefore the volume of the trade is under rather than over estimated.

The following table, giving the amount of freight carried, towed, and rafted, together with the number of passengers, for 1893, but not including any ferriage business, is believed to be a close approximation to the actual trade:

TABLE. 1.

Class.	Grain.	Live stock.	Wood and lumber.	Sand and building material.	Miscellaneous farm produce and general merchandise.	Totals.	Mile-tons.	Passengers.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*		*No.*
Long-trade packets ..	6,238.5	1,246.9	1,623.3	180.4	10,021.8	19,310.9	4,093,147.3	3,700
Short-trade packets and miscellaneous steamers	21,516.4	1,342.2	13,122.3	34,061.5	3,206.1	73,248.5	758,604.2	*8,532
Sand and wood steamers and barges	....	....	8,997.8	137,830.1	....	146,827.9	235,998.3	....
Rafts	....	....	10,578.0	....	....	10,578.0	579,215.3	....
Total	27,754.9	2,589.1	34,321.4	172,072.0	13,227.9	249,965.3	5,766,965.1	12,232

* Including 6,200 excursion passengers.

The following comparative table gives the totals for the different classes of trades during 1893, 1892, and 1891:

TABLE 2.

Class.	Total number of tons carried.			Mile-tons.			Passengers.		
	1893.	1892.	1891.	1893.	1892.	1891.	1893.	1892.	1891.
Long-trade packets	19,310.9	30,372.3	31,458.4	4,693,147.3	6,112,179.6	6,437,472.8	3,700	4,450	6,000
Short-trade packets and miscellaneous steamers	73,248.5	110,449.1	73,866.3	758,604.2	1,411,529.6	1,455,627.6	*8,532	†41,823	8,000
Sand and wood steamers and barges	146,827.9	91,092.6	71,103.3	235,908.3	327,561.7	145,868.7	......	......	......
Rafts	10,578	4,908.9	8,118.1	579,215.3	522,700.8	158,262.3	......	......	......
Total	249,965.3	236,872.9	189,546.1	5,766,965.1	8,373,971.7	8,197,231.4	12,232	46,273	14,000

* Including 6,200 excursion passengers. † Including 34,693 excursion passengers.

In comparing Table 1 with a similar table of the preceding year there appears to be a decrease in 1893 of over one-third in grain and live stock and over one-half in miscellaneous products shipped on the river.

The item of wood and lumber shows a decrease of about 10 per cent, while that of sand and building materials shows an increase of 36 per cent in 1893 over that of 1892.

The mile-tons are about one-third less, the loss showing principally in the packet trades.

The river traffic in 1893 suffered in the general depression of business, as did every other department of industry.

From the report of the secretary of the Merchants' Exchange of St. Louis it appears that the receipts and shipments by river to and from the city during 1893 were over 13 per cent less than in 1892.

The total amount of wheat received in St. Louis in 1893 was nearly 50 per cent less than in 1892, while for total grains, including flour reduced to wheat, the decrease was 18 per cent.

The principal article of shipment on the Missouri River in the packet trade is wheat.

The completion of the M. K. and E. Railroad, skirting the left bank of the river from Boonville down to the Bellefontaine bridge, has contributed not a little in diminishing the amount of freight carried by the short-line packets in the lower river.

The following table gives the number and total registered tonnage of steamboats plying on the Missouri River in the years 1889 to 1893, inclusive:

TABLE 3.

Enrolled at—	1893.		1892.		1891.		1890.		1889.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
St. Louis, Mo	20	2,282.49	24	2,562.78	19	2,504.31	18	1,840.61	16	1,812.66
Kansas City, Mo	11	2,932.42	12	2,980.08	18	3,398.13	17	1,270.33	15	1,626.26
St. Joseph, Mo	3	47.50	3	148.88	5	265.41	5	277.62	5	277.62
Omaha, Nebr	11	911.99	11	912.29	12	794.21	10	504.72	13	1,329.85
Louisville, Ky	...	......	...	......	...	......	1	1,130.34	...	......
St. Paul, Minn	...	......	1	324.09	...	......	...	......	...	......
Dubuque, Iowa	1	58.32	1	58.32	...	......	...	......	...	......
New Orleans, La	...	......	1	358.31	...	......	...	......	...	......
Burlington, Iowa	2	450.84	...	......	...	......	...	......	...	......
Cincinnati, Ohio	1	134.92	...	......	...	......	...	......	...	......
Total	49	6,818.48	53	7,344.75	54	6,962.06	51	5,023.62	49	5,046.09

In addition to the steamboats there are 6 gasoline boats plying in the short packet trade on the Missouri River.

Under the present laws these boats are not subject to Government inspection.

The largest of the gasoline boats is 78 by 14 feet, and their aggregate tonnage is about 182 tons.

The aggregate of their freight carried by them during 1893 is 11,866 tons, which is included in Table 1.

From the weekly reports of the gauge observers and from the registered tonnage of the steam vessels and the approximate tonnage of the gasoline boats, the following table is made up, showing the number of boats passing 6 of the regular water-gauge stations and their tonnage:

TABLE 4.

Locality.	Number of steamers passed.		Registered tonnage.	
	Up.	Down.	Up.	Down.
St. Charles, Mo.	52	52	25,584.21	25,485.33
Coles Creek, Mo. (3.6 miles above Hermann)	208	209	30,568.03	30,560.86
Jefferson City, Mo.	72	73	28,112.28	28,102.56
Boonville, Mo.	50	59	16,689.89	16,599.83
Kansas City, Mo.	18	16	14,039.18	13,916.10
Sioux City, Iowa	21	19	930.31	807.23

Rates of insurance on the river have remained unchanged since July 1, 1889, and are believed to be higher than on any other river comparable in size to the Missouri.

No new line of transportation has been established since the report of last year.

The formation of a line of towboats and barges between St. Louis and Kansas City has been advocated in the public press and has received some attention from capitalists, and it has been asserted that the experiment will be tried on the river during the present crop season.

TABLE 5.—*List of steamers plying on the Missouri River, in the district of New Orleans, enrolled at the port of St. Louis, Mo., during the year 1893.*

Name.	Where built.	Year.	Date of last inspection.	Dimensions. Length.	Breadth.	Depth.	Total tonnage.
				Feet.	Feet.	Feet.	
A. W. Ewing	Osage City, Mo	1878	May 1, 1893	..	...	......	4.00
Benton	Pittsburg, Pa	1875	Aug. 4, 1893	197.0	33.0	5.0	394.06
Black Diamond	Portland, Mo	1886	June 10, 1893	72.5	14.4	2.3	18.40
Commodore	New Haven, Mo	1890	July 7, 1893	97.0	23.2	3.2	86.45
Cherokee	Dubuque, Iowa	1888	July 20, 1893	216.4	33.9	5.4	631.20
Dolphin No. 2	Jeffersonville, Ind	1891	Aug. 26, 1893	150.0	30.0	4.5	186.03
Edna	Boonville, Mo	1887	May 2, 1893	102.4	21.5	4.2	80.35
Fawn	Hermann, Mo	1880	May 8, 1893	91.8	19.1	3.4	73.00
Frederick	Tuscumbia, Mo	1883	May 1, 1893	96.4	14.3	3.0	82.51
Gasconade	Hermann, Mo	1891	July 7, 1893	107.4	23.9	3.5	74.35
John L. Ferguson	Grafton, Ill	1876	Oct. 27, 1893	111.6	26.6	3.6	79.81
John R. Hugo	Evansville, Ind	1879	May 1, 1893	127.0	30.0	3.0	130.88
Jennie Gilchrist	La Crosse, Wis	1871	May 22, 1893	100.5	18.5	3.8	74.48
Little Eagle No. 2	Jeffersonville, Ind	1877	June 9, 1893	130.7	19.2	3.9	82.65
May Bryan	do	1875	Nov. 23, 1893	115.0	28.0	4.5	97.40
Mill Boy	Hermann, Mo	1893	Feb. 6, 1893	89.2	18.8	2.8	41.19
Miranda	Warsaw, Mo	1892	Nov. 23, 1893	..	....	....	*3.00
Patience	Rock Island, Ill	1882	May 2, 1893	76.3	15.7	3.2	48.93
Pin Oak	Hermann, Mo	1888	May 1, 1893	95.0	17.5	2.2	43.05
Royal	do	1884	... do.	86.6	24.0	3.0	44.82

Name.	Staterooms.	Berths.	Passengers. Permitted to carry.	First cabin.	Steerage or deck.	Engines. Number.	Diameter.	Stroke.	Boilers. Number.	Length.	Diameter.	Flues. Number.	Diameter.
							In.	Ft.		Ft.	In.		In.
A. W. Ewing	..	..	8	......	8	1	6	⅞	1	3	40	70	1½
Benton	18	36	60	30	30	2	15½	5	3	24	38	6	13½
Black Diamond	......	..	10	......	10	2	6	3	1	14	30	21	3
Commodore	......	......	50	..	50	2	10	4	1	20	44	6	2-13 4-6
Cherokee	31	77	149	89	60	2	17	7	3	20	40	6	15
Dolphin No. 2	8	16	35	20	15	2	18	7	3	26	42	6	15
Edna	6	12	33	8	25	2	8	3½	1	14	44	10	6
Fawn	3	..	50	......	50	2	8	2	1	14	42	4	2-10 2-12

Table 5.—*List of steamers plying on the Missouri River, in the district of New Orleans, enrolled at the port of St Louis, Mo., during the year 1893*—Continued.

Name.	Passengers: State rooms.	Passengers: Berths.	Passengers: Permitted to carry	Passengers: First cabin.	Passengers: Steerage or deck.	Engines: Number	Engines: Diameter.	Engines: Stroke.	Boilers: Number.	Boilers: Length.	Boilers: Diameter.	Boilers: Flues: Number.	Boilers: Flues: Diameter.
							In.	*Ft.*		*Ft.*	*In.*		*In.*
Frederick	4	7	24	4	20	2	7	2½	1	14	36	6	6
Gasconade	3	6	35	5	30	2	9	3½	1	20	42	5	6-10
John L. Ferguson	..		20	.....	20	2	11	4	1	16	42	12	5
John R. Hugo	5	9	39	9	30	2	12½	3	1	16	42	5	10
Jennie Gilchrist	..		8	.....	8	2	12	3	2	20	31	10	6
Little Eagle No 2	6	12	18	8	10	2	14	5	2	20	38	10	6
May Bryan	.	...	50	......	50	1	16	5	1	22	44	5	{ 3-10 2-12 }
Mill Boy	......	...	20	......	20	2	8	1	1	14	44	1	24
Miranda	..	..	.	......	.....	1	5½	4/12	1	4½	30	Tubular.	
Patience	.		57		57	2	8½	3 1/12	1	15	40	7	{ 4-6 3-7 }
Pin Oak	..	..	20	.	20	2	8	2½	1	17	40	36	3
Royal	.....		20	. . .	20	2	8	2½	1	12	36	5	7

Name.	Boilers: Steel or iron	Boilers: When built	Boilers: Steam pressure allowed.	Licensed to run on—	Name and address of sole or managing owner.
			Lbs.		
A. W. Ewing	Steel	1885	125	Mississippi and tributary rivers.	C. C Turner, Osage City, Mo.
Benton	Iron	1875	125	... do	J R Ern, St Louis Mo.
Black Diamond	Steel	1886	130	. do	Otto Marker, Osceola, Mo.
Commodore	Steel	1890	153	.....do	S. H Schlief, New Haven, Mo
Cherokee	Steel	1888	169	do	Cherokee Packet Co, St. Louis Mo.
Dolphin No. 2	Steel	1891	161	do	Dolphin Transportation Co, St Louis, Mo.
Edna	Steel	1887	160	.do	L C Loeman Jefferson City Mo
Fawn	Iron	1877	110	do	Chas B. Able St. Charles, Mo
Frederick	Iron	1863	150	do	Henry Castrop, Tuscumbia Mo
Gasconade	Steel	1891	160	. ...do	Hermann Ferry and Packet Co, Hermann, Mo.
John L Ferguson	Iron	1864	91	Missouri River 5 miles above and below Jefferson City, Mo.	Cole & Calloway Transportation Co Jefferson City, Mo
John R. Hugo	Iron	1882	114	Mississippi and tributary rivers.	R. M Marshall, Tuscumbia Mo
Jennie Gilchrist	Steel	1879	169	..... do	Argentine Sand Co Kansas City Mo.
Little Eagle No. 2	Iron	1877	151	.... do	Southern Transportation and Lumber Co St. Louis Mo
May Bryan	Iron	1875	113	Missouri River from St Charles Mo, to 10 miles above Hermann. Mo.	Washington Ferry Co., Washington Mo
Mill Boy	Steel	1893	110	Mississippi and tributary rivers	Hermann Ferry and Packet Co. Hermann, Mo.
Miranda	Steel	1891	135	......do	Edward Kirkendall Washington, Mo.
Patience	Steel	1890	160	.. . do	Henley H. Moore, Jefferson City, Mo
Pin Oak	Steel	1888	125	Missouri and tributary rivers	Hermann Ferry and Packet Co, Hermann, Mo.
Royal	Steel	1884	125	.....do	Do.

* Estimated. † Twenty second cabin.

TABLE 6.—*List of steamers plying on the Missouri River, in the district of New Orleans, enrolled at the port of Kansas City, Mo., during the year 1893.*

Name.	Where built.	Year	Date of last inspection.	Dimensions. Length.	Breadth.	Depth.	Total tonnage.
				Feet.	*Feet.*	*Feet.*	
A. L. Mason	Madison, Ind	1890	June 23, 1893	252.0	52.6	6.0	1,130.34
Alda	Boonville, Mo	1891	May 23, 1893	121.0	21.2	4.0	73.80
Annie Cade	Leavenworth, Kans	1879	July 3, 1893	127.5	32.0	4.5	178.32
Belle of Brownville	Grafton, Ill	1880	May 25, 1893	110.0	30.0	4.0	102.44
Joseph L. Stevens	Jeffersonville, Ind	1887	May 23, 1893	103.0	29.4	4.2	85.95
Krata	St. Louis, Mo	1888	May 25, 1893				*5.00
Mattie Lee	Grafton, Ill	1881	May 24, 1893	110.0	26.0	4.0	104.81
Plow Boy	Sioux City, Iowa	1884	May 23, 1893	77.7	21.4	5.8	29.22
Roy Lynds	Jeffersonville, Ind	1887	May 24, 1893	87.0	25.0	3.6	64.19
St. Elmo	Dewitt, Mo	1891	May 22, 1893	57.0	17.4	3.0	28.01
State of Kansas	Madison, Ind	1890	Aug. 14, 1893	252.0	52.6	6.0	1,130.34

* Estimated.

Name.	Staterooms.	Berths.	Passengers. Permitted to carry.	First cabin.	Steerage or deck.	Engines. Number.	Diameter.	Stroke.	Boilers. Number.	Length.	Diameter.	Flues. Number.	Diameter.
							Ins.	*Ft.*		*Ft.*	*Ins.*		*Ins.*
A. L. Mason	11	22	100	50	50	2	20	7	4	28	42	16	10
Alda	6	12	58	8	50	2	10	6	1	22	42	10	6
Annie Cade						1	20$\frac{1}{16}$	5½	2	16	42		
Belle of Brownville						1	16	4	1	18	48		
Joseph L. Stevens						2	10	3½	1	10	48		
Krata						2	5⅛	$\frac{1}{2}$	1	12	40	53	2-3
Mattie Lee	2	4	30		30	1	16	4½	1	20	48	6	{ 2-14 / 4-8 }
Plow Boy			10		10	2	8	2	1	14	40	40	3
Roy Lynds						2	9	3	1	18	42		
St. Elmo			25		25	2	7	3	1	12	40	7	6
State of Kansas	11	22	125	50	75	2	20	7	4	28	42	16	10

Name.	Boilers. Steel or iron.	When built.	Steam pressure allowed.	Licensed to run on—	Name and address of sole or managing owners.
			Lbs.		
A. L. Mason	Steel	1890	160	Mississippi and tributary rivers.	Kansas City and Missouri River Transportation Co., Kansas City, Mo.
Alda	Steel	1891	153	.....do	Benjamin McMahon, Boonville, Mo.
Annie Cade	Iron	1879	119	Missouri River and opposite shore.	William A. Cade, Kansas City, Mo.
Belle of Brownville	Steel	1880	145	.....do	James W. Morgan, Leavenworth, Kans.
Joseph L. Stevens	Steel	1887	125	.....do	James L. Porter, Boonville, Mo.
Krata	Iron	1894	80	Missouri River and tributaries.	Hale Chapman, Armourdale, Kans.
Mattie Lee	Iron	1881	130	Missouri River, 10 miles above and below Miami, Mo.	John Burruss, Miami, Mo.
Plow Boy	Steel	1883	150	Mississippi and tributary rivers.	Dewitt N. Smith, Boonville, Mo.
Roy Lynds	Steel	1887	125	Missouri River and opposite shore.	Lexington Coal, Ferry, Railroad, and Transportation Co., Lexington, Mo.
St. Elmo	Steel	1891	155	Missouri and tributary rivers.	Orris J. Miller, Nevada, Mo.
State of Kansas	Steel	1890	160	Mississippi and tributary rivers.	Kansas City and Missouri River Transportation Co., Kansas City, Mo.

Table 7.—*List of steamers plying on the Missouri River, in the District of New Orleans, enrolled at the port of St. Joseph, Mo., during the year 1893.*

Name.	Where built	Year.	Date of last inspection	Dimensions. Length.	Dimensions. Breadth.	Dimensions. Depth.	Total tonnage.
				Feet	*Feet*	*Feet.*	
Bee	St. Joseph, Mo	1893	June 13, 1893	53.5	13.5	3.5	16.42
Harry Lynds	White Cloud, Kans	1892	Mar 17, 1893	64.0	18.0	3.0	27.08
Princess	St Joseph, Mo	1889	Aug. 26, 1893				*4.90

* Estimated

Name.	Passengers. Staterooms.	Passengers. Berths.	Passengers. Permitted to carry.	Passengers. First cabin.	Passengers. Steerage or deck.	Engines. Number.	Engines. Diameter.	Engines. Stroke.	Boilers. Number.	Boilers. Length.	Boilers. Diameter.	Boilers. Flues. Number.	Boilers. Flues. Diameter.
							Ins	*Ft.*		*Ft.*	*Ins.*		*Ins.*
Bee			10		10	1	8	1	1	11½	34	†26	3
Harry Lynds			20		20	1	7	$\frac{10}{12}$	1	7	30	1	12
Princess			16		16	1	4½	$\frac{5}{12}$	1	3	24		

† Tubes.

Name	Boilers. Steel or iron.	Boilers. When built.	Boilers. Steam pressure allowed	Licensed to run on—	Name and address of sole or managing owner.
			Lbs.		
Bee	Steel	1887	120	Missouri and tributary rivers, 2,000 miles and return.	John Davis, St. Joseph, Mo.
Harry Lynds	Iron	1883	120	Missouri River, 10 miles above and below White Cloud, Kans.	John H. Lynds, White Cloud, Kans.
Princess	Steel	1891	125	Missouri River, 10 miles above and below St. Joseph, Mo.	Michael Hilgert, St. Joseph, Mo.

TABLE 8.—*List of steamers plying on the Missouri River, in the district of New Orleans, enrolled at the port of Omaha, Nebr., during the year 1893.*

Name	Where built	Year.	Date of last inspection.	Dimensions: Length	Dimensions: Breadth.	Dimensions: Depth.	Total tonnage.
				Feet	*Feet*	*Feet*	
Andrew S. Bennett	Sioux City, Iowa	1880	....	115.0	30.0	3.5	78.08
Castalia	do	1892	Sept. 5, 1893	110.0	26.2	3.7	90.06
Capitola Butt	Montrose, Iowa	1865	May 20, 1893	83.7	23.3	3.3	57.31
Jim Leighton	Sioux City, Iowa	1880	Aug 13, 1893	96.0	25.0	4.0	57.29
Josie L. K.	Chamberlain, S. Dak	1884	Aug 28, 1893	60.0	14.0	2.5	23.45
Last Chance	Burlington, Iowa	1870	Sept 14, 1893	98.2	17.8	3.0	50.47
Little Maud	Sioux City, Iowa	1882	July 11, 1893	92.0	20.0	3.4	58.66
Mary E. Bennett	Covington, Nebr	1888	Aug 26, 1893	65.0	14.0	2.5	21.71
Queen No. 2	Tieville, Iowa	1879	Aug 30, 1893	44.0	12.0	2.0	12.00
Rosebud	Pittsburg, Pa	1877	July 18, 1893	177.4	31.3	4.0	286.49
Vint Stillings	Metropolis, Ill	1881	May 27, 1893	131.0	31.6	4.8	177.47

Name.	Staterooms	Berths	Passengers: Permitted to carry	Passengers: First cabin	Passengers: Steerage or deck	Engines: Number	Engines: Diameter.	Engines: Stroke	Boilers: Number.	Boilers: Length	Boilers: Diameter.	Boilers: Flues: Number.	Boilers: Flues: Diameter.
							In.	*Feet*		*Feet*	*In.*		*In.*
Andrew S. Bennett	....		75	..	75	2	11½	4½	1	22	48	6	{2-14 {4-7½
Castalia	6	12	22	7	15	2	10	4	1	20	42	6	{4-6 {2-10
Capitola Butt		...	20	......	20	2	11	3½	1	20	46	10	7
Jim Leighton	...	...	...	......	...	2	11½	3½	1	22	48	...	......
Josie L. K.	....		30	.....	30	1	6	1	1	$6\frac{7}{12}$	42	52	2½
Last Chance	...		32	2	30	2	11	3	1	18	42	4	{2-6 {2-10
Little Maud	..	..	.		.....	2	10½	3	1	24	40	......	.....
Mary E. Bennett	..	.	10	...	10	2	{7½ {7½	{2½	1	18	38	5	8
Queen No. 2	..	.	.....		....	1	7½	¾	1	7½	30	....	.....
Rosebud	11	20	23	23	.....	2	{13½ {13½	{5	2	24	45	10	9
Vint Stillings	....		.....	..	....	1	20	5	2	22	42	...	...

Name.	Boilers: Steel or iron.	Boilers: When built	Steam pressure allowed	Licensed to run on—	Name and address of sole or managing owner
			Lbs		
Andrew S. Bennett	Steel	1883	140	Mississippi River and tributaries	D. Ayers, Ponca Dixon County, Nebr.
Castalia	Steel.	1892	160	do	B. S. Holmes, Sioux City, Ia.
Capitola Butt	Steel	1885	145	do	E. A. Conway, Sioux City, Ia.
Jim Leighton	Steel	189.	135	Missouri River and opposite shore at Pierre, S. Dak	Chicago and Northwestern Rwy Co
Josie L. K.	Steel	1888	120	Mississippi River and tributaries	Yankton Bridge and Ferry Co Yankton, S. Dak
Last Chance	Iron	1870	85	do	M. K. King, Chamberlain, S. Dak.
Little Maud	Steel	1889	156	Missouri and tributary rivers between Fort Randall, S. Dak., and Niobrara, Nebr	Jos Leach, Sioux City, Ia.
Mary E. Bennett	Steel	1891	170	Mississippi and tributary rivers	R. A. Talbot, Covington, Nebr.
Queen, No. 2	Iron	1877	110	Missouri River at ferry crossings	George Anderson, Decatur, Nebr.
Rosebud	Steel	1882	149	Mississippi and tributary rivers	Sioux City Packet Co., Sioux City, Iowa.
Vint Stillings	Iron	1878	135	Missouri River and opposite shore.	Selzer Bros., Sioux City, Ia.

TABLE 9.—*List of steamers plying on the Missouri River, in the district of New Orleans, enrolled at the port of Burlington, Iowa, during the year 1893.*

Name.	Where built.	Year.	Date of last inspection.	Dimensions. Length.	Dimensions. Breadth.	Dimensions. Depth.	Total tonnage.
				Feet.	*Feet.*	*Feet.*	
John Bertram	Jeffersonville, Ind	1880	Aug. 16, 1893	160	34.0	5.0	390.49
Pauline	Louisville, Ky	1890	May 25, 1893	95	23.6	3.3	60.85

Name.	Staterooms.	Berths.	Passengers. Permitted to carry	Passengers. First cabin	Passengers. Steerage or deck.	Engines. Number	Engines. Diameter.	Engines. Stroke.	Boilers. Number.	Boilers. Length.	Boilers. Diameter	Boilers. Flues. Number	Boilers. Flues. Diameter.
							Ins.	*Ft.*		*Ft.*	*Ins.*		*Ins.*
John Bertram						2	20	6½	4	24	38		
Pauline	5	8				2	10½	2	1	24	40	2	15

Name.	Boilers. Steel or iron	Boilers. When built	Steam pressure allowed	Licensed to run on—	Name and address of sole or managing owner
			Lbs		
John Bertram	Iron	1880	150	Mississippi and tributary rivers	St. Louis, Keokuk and Northwestern R'wy.
Pauline	Steel	1883	160	do	do

TABLE 10.—*List of steamers plying on the Missouri River, in the district of New Orleans, enrolled at the port of Dubuque, Iowa, during the year 1893.*

Name.	Where built.	Year.	Date of last inspection.	Dimensions. Length.	Dimensions. Breadth.	Dimensions. Depth.	Total tonnage.
				Feet.	*Feet.*	*Feet.*	
Geo. L. Bass	Dubuque, Iowa	1885	June 5, 1893	91	21	3.3	58.32

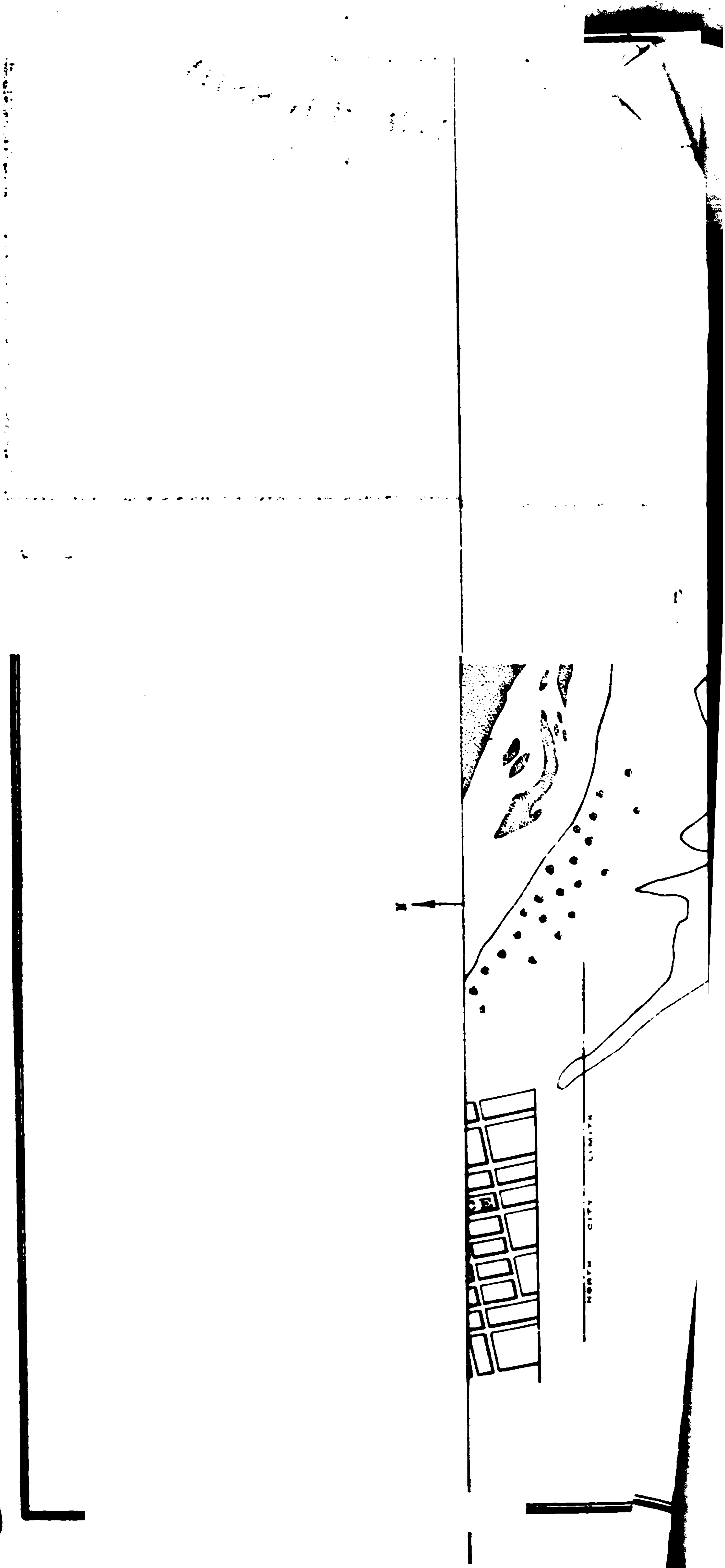
Name.	Staterooms.	Berths.	Passengers. Permitted to carry.	Passengers. First cabin.	Passengers. Steerage or deck.	Engines. Number.	Engines. Diameter.	Engines. Stroke.	Boilers. Number.	Boilers. Length.	Boilers. Diameter.	Boilers. Flues. Number.	Boilers. Flues. Diameter.
							Ins.	*Ft.*		*Ft.*	*Ins.*		*Ins.*
Geo. L. Bass		20	20		20	2	10	4	1	16	42	10	6

Name.	Boilers. Steel or iron.	Boilers. When built.	Steam pressure allowed.	Licensed to run on—	Name and address of sole or managing owner.
			Lbs.		
Geo. L. Bass	Steel	1885	166	Mississippi and tributary rivers.	Jas. Johnson, Dubuque, Iowa.

Very respectfully, your obedient servant,

JAMES F. MCINDOE,
Additional Second Lieut. of Engineers,
Secretary.

Lieut. Col. CHAS. R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.


NORTH CITY LIMITS

APPENDIX B.

ANNUAL REPORT OF S. WATERS FOX, DIVISION ENGINEER, OMAHA DIVISION, 1894.

MISSOURI RIVER COMMISSION,
OFFICE OF DIVISION ENGINEER, OFFICE BOAT MARGARET,
Gasconade, Mo., June 30, 1894.

COLONEL: I have the honor to submit herewith a report of the operations under my charge, on the Omaha division of the Missouri River, during the fiscal year ending June 30, 1894. A map of the river in the vicinity of Council Bluffs, Iowa, showing location of the work done, accompanies.

In compliance with your instructions, a project was submitted, under date of August 29, 1893, for the expenditure of $15,000, allotted for the repair of revetment in the vicinity of Council Bluffs, Iowa. It provided for the repair of the break in the Council Bluffs bend revetment by entirely new upper bank work throughout its length, and with new mattress where necessary.

An office was opened in Council Bluffs, Iowa, October 17, 1893, and measures taken at once for carrying on the work as approved. The necessary cable, strand, rock, and brush were purchased in open market, except 120 cords of the latter item, which was procured by hired labor. Under authority dated October 23, 1893, the following plant was chartered for use on the work, viz:

One floating pile-driving apparatus, complete, with steam hoist, lines, and all accessories, at $20 per day.

One floating hydraulic-grading apparatus, complete, with steam pump, 2½-inch hose, lines, and all accessories, at $18 per day.

Three barges at $100 per month for the three. One of the barges, 30 by 100 feet, was provided with ways for use as a mattress boat.

The removal of rock ballast from the upper bank of the old work was begun November 1. The driving of piles for anchorage of mattress began the next day, and, owing to failure in delivery of piles, was not finished until the 24th of that month. One hundred and seventy-four piles were driven to an average penetration of 20.14 feet each. The grader was in service from November 8 to 26, during which time 1,265 linear feet of bank, containing 3,535 cubic yards of earth, were graded. In addition to this, 519 linear feet of bank, containing 1,422 cubic yards of earth, were graded by teams with scrapers. Weaving of mattress was begun November 10 on the upstream side of Gumbo Point, shown on the accompanying map at C. By November 22, a mattress had been woven in one piece 910 feet long and of average width of 122 feet. It was 155 feet wide at a point 350 feet below its head. This covered the break in the old work below the Gumbo Point, and shown on the map C to D, leaving a break of 1,674 feet in the old work above the Point and which was repaired as follows, viz: From A to B, a distance of 800 feet, the upper bank was faired out to grade where necessary with brush and then ballasted with a full quota of riprap stone; from B to C, a new mattress 874 feet in length and averaging 52 feet in width was put in, and the upper bank regraded and ballasted. On account of the severity of the winter weather and ice movements in the river, in one of the latter of which, on the night of November 23, the mattress boat was torn from its moorings and carried to a point below the interstate bridge, frequent and costly interruptions and suspensions of operations occurred, necessitating an additional allotment, by transfer, of $1,800 and prolonging the work until March 31, 1894, at which time it was finished. The Government property that had been used on the work was then shipped to Gasconade, Mo., and the office closed April 2, 1894. Cost exhibits in detail are given in the accompanying appendix.

Very respectfully, your obedient servant,

S. WATERS FOX,
Division Engineer.

Lieut. Col. CHARLES R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

EXHIBIT A.—*Cost in detail of 910 feet of revetment in Council Bluffs Bend.*

Classification and extent.	Cost per unit.	Cost of each item.	Cost per linear foot.	Total cost.
Driving anchor piling, 104, viz:				
Labor	$1.4767	$153.58		
Fuel	.2019	21.00		
Oil and waste	.0192	2.00		
Material, 57 oak piles, 30 feet long, at $4; 47 oak piles, 25 feet long, at $3.40	3.7288	387.80		
Charter of plant, 14 days at $20 per day	2.6923	280.00		
Total	8.1189	844.38	$0.9279	$844.38
Weaving 910 linear feet of mat, viz:				
Labor	1.0152	923.84		
Material	1.5577	1,417.50		
Charter of plant, 1⅖ months at $75 per month	.1154	105.00		
Total	2.6883	2,446.34	2.6883	2,446.34
Anchoring 910 linear feet of mat, viz:				
Labor	.1520	138.36		
Strand, ⅜-inch, 42,680 linear feet	.3880	353.05		
Cable, 1¼-inch, 1,200 linear feet	.0212	19.26		
Wire, No. 8, 183 pounds	.0055	5.03		
Total	.5667	515.70	.5667	515.70
Hydraulic grading, 1,554 cubic yards, viz:				
Labor	.1191	185.17		
Fuel	.0575	89.40		
Oil and waste	.0064	10.00		
Charter of plant, 10½ days at $18 per day	.1216	189.00		
Total	.3046	473.57	.5204	473.57
Bank grading with scrapers and teams, 422 cubic yards, labor	.1393	58.80	.0646	58.80
Ballasting 910 linear feet of revetment:				
Labor, placing 1,931.15 cubic yards	.2649	511.56		
Labor, removing 686.17 cubic yards from old work	.4548	312.06		
Material, 1,244.98 cubic yards, new rock	1.9500	2,427.71		
Material, 16 cords of brush	2.7000	43.20		
Charter of plant, two barges 30 days each	12.5000	25.00		
Total			3.6478	3,319.53
Grand total			8.4157	7,658.32

EXHIBIT B.—*Cost in detail of 874 feet of revetment at Council Bluffs Bend.*

Classification and extent.	Cost per unit.	Cost of each item.	Cost per linear foot.	Total cost.
Driving 70 anchor piling, viz:				
Labor	$1.2961	$90.73		
Fuel	.2000	14.00		
Material, 52 oak piles 30 feet long, at $4 each; 18 oak piles 25 feet long, at $3.40 each	3.8457	269.20		
Charter of plant, 8 days at $20 per day	2.2857	160.00		
Total	7.6275	533.93	$0.6109	$533.93
Weaving 874 linear feet of mat, viz:				
Labor	.3897	340.61		
Material	.8484	741.53		
Charter of plant, 2 barges 2 months 12½ days at $12.50 each	.0691	60.42		
Total	1.3072	1,142.56	1.3072	1,142.56
Anchoring 874 linear feet of mat, viz:				
Labor	.1303	113.87		
Strand, ⅜ inch, 21,112 linear feet	.1998	174.61		
Cable, 1¼ inch, 5,250 linear feet	.1018	89.01		
Total	.4319	377.49	.4319	377.49

EXHIBIT B.—*Cost in detail of 874 feet of revetment at Council Bluffs Bend*—Continued.

Classification and extent.	Cost per unit.	Cost of each item.	Cost per linear foot.	Total cost.
Hydraulic grading 1,981 cubic yards, viz:				
Labor	$0.0760	$150.50		
Fuel	.0425	84.30		
Charter of plant, 5½ days at $18 per day	.0500	99.00		
Total	.1685	333.80	$0.3819	$333.80
Bank grading, with scrapers and teams, 1,000 cubic yards, labor	.1036	113.64	.1300	113.64
Ballasting 874 linear feet of revetment:				
Labor, placing 1521.97 cubic yards of rock	.1158	275.77		
Material, 1,521.97 cubic yards of rock at $1.95 per yard	1.9500	2,967.84		
Total	2.0658	3,243.61	3.7112	3,243.61
Grand total			6.5732	57,745.03

EXHIBIT C.—*Cost in detail for repairing 800 linear feet of upper bank work at Council Bluffs Bend.*

Classification and extent.	Cost per unit.	Cost of each item.	Cost per linear foot.	Total cost.
Labor, procuring and placing 120 cords of brush	$0.2381	$190.50		
Labor, removing and replacing rock	.2106	168.51		
Material, 280 cubic yards of rock at $1.95 per yard	.6825	546.00		
Total	1.1312	905.01	$1.1312	$905.01

EXHIBIT D.—*Cost of miscellaneous items of new plant, repair, care, and transportation of plant, and administration.*

New plant:			
Rope		$61.82	
Stage plank		104.56	
			$166.38
Repairs to plant:			
Labor		375.37	
Lumber	$179.73		
Oakum and nails	30.73	210.46	
			585.83
Care and preservation of plant:			
Watching	277.50		
Pulling out and launching boats	569.36		
Moving property	205.23		
		1,052.09	
Freight charges		92.86	
			1,144.95
Administration:			
Labor		593.00	
Office rent		144.73	
Traveling expenses		200.45	
			938.18
Total			2,835.34

APPENDIX C.

ANNUAL REPORT OF S. WATERS FOX, DIVISION ENGINEER, ST. JOSEPH DIVISION, 1894.

MISSOURI RIVER COMMISSION,
OFFICE OF DIVISION ENGINEER, OFFICE BOAT MARGARET,
Gasconade, Mo., June 30, 1894.

COLONEL: I have the honor to submit the following report of the operations under my charge on the St. Joseph division of the Missouri River for the fiscal year ending June 30, 1894.

The only work done on this division was in Belmont Bend, on the St. Joseph Reach, during the fall and winter of 1893. The approved project, submitted under date of May 27, 1893, provided for the construction of 3,500 feet of revetment to close the gap between the works in Belmont and Elwood Bends, and the reinforcement with rock ballast of 4,500 linear feet of the upper bank of the old Belmont revetment. Notification of the approval of an allotment of thirty thousand dollars ($30,000) for expenditure in accordance therewith, was received under date of June 24, 1893. An office was opened in St. Joseph September 11, 1893, and measures taken at once for carrying on the work. All of the construction materials were purchased in open market. As none of the floating plant under charge of the Commission was available, the following pieces were chartered under authority from the Chief of Engineers, U. S. Army, dated September 1, 1893, viz:

	Per day.
One steamer, with crew	$22.00
One sand dredge	8.00
Two barges, each	3.00
One barge	2.00

Two of the barges were provided with ways, brush platforms, capstans, etc., necessary for their use as mattress boats. The sand dredge was dismantled and outfitted with a Davidson's pump 18 by 18 by 10½ inches, 4-inch hose, and other accessories necessary for use as an hydraulic grader.

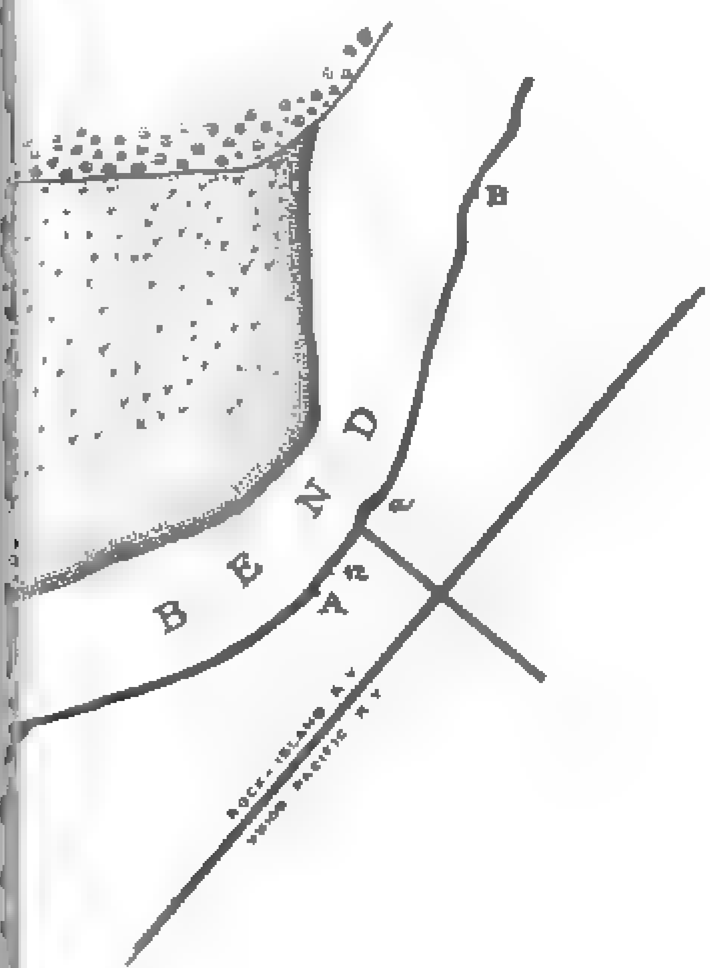
Weaving mattress began with one party October 8 at a point 1,110 feet below point A on the accompanying map. A second party began weaving October 24 at the point A. The former finished work November 24; the latter, November 8. The total length of mattress woven was 4,598 feet, protecting 4,513 linear feet of bank, shown on the accompanying map A to B. The maximum width of mattress at any point was 12[illegible] feet; the average width 85.75 feet. The driving of piles for shore anchorage of the mattress was begun October 9 and finished November 30. Four hundred and fifty-seven piles were driven to an average penetration of 19.54 feet each. The progress of this branch of the work and of mattress construction was seriously retarded by failure in delivery of materials. Hydraulic bank grading was begun October 10 and carried on, with some interruptions, on account of ice in the river, until November 30, at which time it was finished. Four thousand and one linear feet of bank, containing 32,575 cubic yards of earth, were graded. The ballasting of the upper bank was finished December 16. The delivery of the chartered plant to the owners at St. Joseph, as provided in the charter, having been made impossible by the closing of the river with ice, an agreement was reached by which they were to accept the plant if pulled out on the bank at the lower end of the work. All of the hulls, except the steamer and one barge (the latter being wrecked by consent of the owners), were pulled out by December 16 and a release from further liability secured. The Government property and records were then shipped to Gasconade, Mo., and the St. Joseph office closed December 23, 1893. Exhibits of cost in detail of the work are given in the appendix.

A partial shore-line survey in Belmont Bend, to show the location of the new revetment, was made May 9, 1894. At that time a break about 100 feet long in the upper bank work, at (A) on the map, was reported. Under date of June 11 an estimate of cost for the repair of the break was submitted. The work will be undertaken as soon as the river has receded to a proper working stage.

Very respectfully, your obedient servant,

S. WATERS FOX,
Division Engineer.

Lieut. Col. CHARLES R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.



...rt for 1894, of S. Waters Fox, Div. Eng'r.

EXHIBIT A.—*Cost in detail of 4,513 linear feet of revetment in Belmont Bend, 1893.*

Classification and extent.	Cost per unit.	Cost of each item.	Cost per linear foot.	Total cost.
Purchase of 8,336.94 cubic yards of rock	$1.1000	$9,170.63	$2.0320	$9,170.63
Purchase of 257 cords of willow brush	1.5000	385.50		
Purchase of 1,313.41 cords of willow brush	2.4500	3,217.86		
Total		3,603.36	.7984	3,603.36
Weaving 4,598 linear feet of mattress, viz:				
Labor	.5574	2,563.21		
Charter of plant	.0851	384.00		
Total	.6425	2,947.21	.6515	2,947.21
Anchoring 4,598 linear feet of mattress:				
Labor	.1242	571.32		
Strand, $\frac{3}{8}$-inch, 46,152 pounds, at 3.23 cents per pound	.3242	1,490.71		
Cable, 1$\frac{1}{4}$-inch, 53,410 pounds, at $\frac{3}{4}$ cent per pound	.0871	400.57		
Total	.5355	2,462.60	.5457	2,462.60
Hydraulic grading, 32,575 cubic yards, viz:				
Labor	.0315	1,026.49		
Fuel	.0107	348.30		
Supplies	.0013	42.10		
Charter of plant	.0162	528.00		
Total	.0597	1,944.89	.4309	1,944.89
Driving anchor piling, viz:				
Labor	1.4710	672.24		
Fuel	.0656	30.00		
Material, 457 piles	1.3125	599.80		
Charter of plant	.2844	130.00		
Total	3.1335	1,432.04	.3173	1,432.04
Placing 8,336.94 cubic yards of rock, labor	.3945	3,288.99	.7288	3,288.99
Grand total			5.5046	24,849.72

EXHIBIT B.—*Miscellaneous data and elements of cost of 4,513 linear feet of revetment in Belmont Bend, 1893.*

Linear feet of revetment	4,513
Linear feet of mattress	4,589
Square feet of mattress	394,278.50
Average width	85.75
Total cost	$24,849.72
Cost per linear foot of revetment	$5.5046
Cost per square (100 square feet)	$6.30

EXHIBIT C.—*Cost of miscellaneous items of new plant, repair, care, and transportation of plant and administration.*

New plant:			
Rope		$130.83	
Lumber		23.49	
Cable, steel		10.72	
Brooms		1.50	
			$166.54
Repairs to plant:			
Labor		639.60	
Lumber and nails		439.20	
			1,078.80
Care of plant:			
Watching	$317.94		
Pulling out boats	271.81		
Moving property	223.00		
		812.75	
Charter, towboat		110.00	
			922.75
Administration:			
Labor		1,691.56	
Office rent		52.50	
Traveling expenses		182.65	
			1,926.71
Survey, labor			11.02
Grand total			4,105.82

APPENDIX D.

ANNUAL REPORT OF S. WATERS FOX, DIVISION ENGINEER, KANSAS DIVISION, 1894.

MISSOURI RIVER COMMISSION,
OFFICE OF DIVISION ENGINEER, OFFICE BOAT MARGARET,
Gasconade, Mo., June 30, 1894.

COLONEL: I have the honor to submit the following report of the operations under my charge, on the Kansas City division of the Missouri River, for the fiscal year ending June 30, 1894.

Work on this division was confined to the loading of plant and construction materials on barges at East Bottoms, near Kansas City, and the care of plant while awaiting transportation from that point to Gasconade, Mo.

On July 1, 1893, there were 28 hulls at East Bottoms. These were taken away in tow by the steamer *Gasconade* and the United States tow boat *Alert*; the former taking 7 hulls in 2 tows on July 4 and 12, respectively; the latter took 21 hulls in 3 tows, leaving East Bottoms July 6, 17, and 24.

The expense of all of the above operations was charged to the allotment for systematic improvement in first reach.

Very respectfully, your obedient servant,

S. WATERS FOX,
Division Engineer.

Lieut. Col. CHARLES R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

APPENDIX E.

ANNUAL REPORT OF SAMUEL H. YONGE, DIVISION ENGINEER, OSAGE DIVISION, 1894.

MISSOURI RIVER COMMISSION,
OFFICE OF DIVISION ENGINEER,
Jefferson City, Mo., June 30, 1894.

COLONEL: I have the honor to submit my report of the operations conducted under my charge on the work of improving the Missouri River on Osage division of first reach during the fiscal year ending June 30, 1894, as follows:

SYSTEMATIC IMPROVEMENT IN THE FIRST REACH.

Projects.—The construction of improvement works was, with one exception, viz, Dike 21A, carried on under approved projects fully described in former reports. The several works, and the projects of which they form parts, are as follows, viz: The construction of incomplete parts of Dikes B and C of the project of February 9, 1892; the extension of Dikes 17A, 18A, and 19A, under project of February 17, 1892, as amended in project of March 21, 1893; the completion of Dikes 20 and 21 to the lines of rectification as fixed by the latter project; the construction of Dike 34, and of parts of Dikes 26, 27, 28, 29, 35, and 36 also of the latter project. The construction of Dike 21A became necessary to meet a change in the direction of flow on the Barkersville crossing, caused by the formation of a reef whereby Dike 22 was threatened with being flanked. Your verbal approval for its construction was given July 28, 1893.

After the river had fallen sufficiently to observe the effects of Dikes B, C, and D of the Cedar City group, it became apparent that these dikes alone were not sufficient to entirely prevent a flow into Cedar City Chute, to accomplish which at least one more dike would be required. In pursuance of your instructions, a survey and examination of the river in that vicinity were made in July, on which a report was submitted recommending a modification of the project of February 9, 1892, by changing the proposed location of Dike E so as to make it normal to the general direction of flow from the main river into the chute (see Pl. I). Your approval of the above recommendations was given in August, and I was at the same time instructed to proceed with the work when it should become possible to do so. It was not possible, however, to construct the dike during the summer and fall of 1893, on account of all the available plant being required for more urgent works, nor in the spring of 1894, on account of there being no funds available for the purpose.

By your letter of August 29, 1893, I was directed to proceed with the work of extending the Murrays Bend revetment of 1892 to the foot of the bend, in accordance with the approved project of August 19, 1892.

In the early part of September I received your verbal instructions to proceed with the construction of the low-water dam, between the Osage and Missouri rivers, at the head of Dodds Island, proposed in the project of March 22, 1893.

Two projects with estimates of cost and extent of work required for extending the improvement of the Missouri River from the head of Isbell section to Portland, Mo., were submitted in compliance with your verbal instructions, under date of December 19, 1893.

DIKE CONSTRUCTION.

During the summer and fall seasons dike construction was carried on at 15 dikes. Two parties were engaged in the work—the first being employed from July 6 to September 30, the second from July 21 to November 19.

Preparations for resuming dike work were made in April and a party sent out May 2 to complete the pile driving and bracing as far as practicable. Field operations were suspended May 30, on account of the funds allotted for spring work being expended. During the above periods the equivalent in 3-row dike of 1, 2, 3, and 4 row dike completed amounted to 10,218 linear feet. The foot mat for 1,045 linear feet of dike was also woven and ballasted and several dikes repaired. This comprised all the dike work, whose construction had been approved, that could be reached by the plant. The details of some of the dikes constructed differ from those used formerly, as follows, viz: Cypress piles used instead of native oak; white oak piles employed for 200 feet, instead of 100 feet, at the stream end; the length of bent increased to 10 feet; the dimensions of the longitudinal and transverse braces increased; the top diagonals omitted; long-leaf yellow pine used for braces instead of the short-leaf variety, and three-fourth inch round iron screw bolts substituted for the five-eighth inch square drift bolts. The details of bracing are shown on Pl. ii. The dikes constructed with the above changes are 26, 27, 28, 29, 34, 35, 36, and the outer part of 19 A.

Dike B.—At the close of the last fiscal year, 368 feet of Dike B had not been completed on account of the stage of water not having been high enough to give sufficient depth for the floating plant on that length of dike. Advantage was taken of a temporary high stage between July 6 and 13 to connect the dike with the bank by completing 175 feet. The remaining 193 feet, however, were not completed on account of being inaccessible.

Dike C.—During the temporary high stage mentioned above Dike C was completed by constructing 75 feet at its shore end.

Dike 20.—After proceeding with work at B and C as far as it was practicable, the party was moved to Dike 20, where pile-driving with a steam hammer was begun July 14. The dike was extended 497 feet to the line of rectification and a wing 50 feet long constructed under the stream end.

Pile-driving was completed on the 22d, and the dike entirely completed August 3. White-oak piles were used for the outer 200 feet and wing, and native-oak piles for the remainder of the dike.

Dike 21.—Pile-driving on the extension of Dike 21 was begun with a steam hammer July 24 and completed July 30. The dike was extended 206 feet to the line of rectification.

On account of the scour that had taken place at the outer end of the work after operations were suspended last year the depth of water was too great to make a direct connection between the old and the new work, and the extension had to be begun 90 feet back from the end of the former and 80 feet above it, involving the construction of 306 feet of 3-row dike and 97 feet of 2-row dike, 47 feet of the latter being the connection between the old and the new work and 50 feet wing.

The work was carried on under considerable difficulties on account of the deep water and the strong current in which the dike had to be constructed. The dike, however, was successfully completed without accident, excepting a collision between the packet *A. L. Mason* and the plant. This accident was probably unavoidable, as the outer end of the dike where the plant was employed was directly in the channel, which was very close and crooked. The damage done was inconsequential.

Dike 21 A.—The effect of the dikes constructed immediately above Barkersville and those opposite them in 1892 and 1893 was to concentrate the flow and cause it to wash away the head of the middle bar opposite Barkersville, the crossing moving down stream as the bar cut away; also to fill up to a certain extent the old channel along the north bank in that locality.

The effect of the dikes in causing the bar to cut away became in a measure spent opposite Dike 20, and the volume of flow divided about equally in two parts on the head of the bar below, one part flowing into Osage Chute, the other into the old channel between dikes 21 and 22. The right side of the bar gradually extended and the flow in the old channel was forced by that across the head of the bar against the dikes, by which action the suspension of navigation in this chute was for a time threatened.

The change in position of the bar described above is shown on Pl. III; from which it appears that during the period of about one year the head of the bar moved downstream about 3,000 feet.

Work on Dike 21 A was begun August 1. It could not be carried to the line of rectification, as it would have crossed the steamboat channel, thereby closing navigation, nor connected with the main bank on account of a wide foreshore. The part constructed consisted of 136 linear feet of ballasted foot mat between the main bank and the water's edge, 183 feet of 2-row dike, and 167 feet of 3-row dike with a short wing.

The difficulties of constructing the dike on account of the current were greater than ever before experienced on this work and the progress made was slow.

Work was suspended August 17, the dike having been carried as far as it was then practicable.

The work remaining to complete the dike consists of driving and bracing piles for 136 feet at the shore end and extending the dike to the line of rectification, a distance of 450 feet.

Dike 17 A.—The invariable heavy scour that occurs at the stream end of dikes projecting into the current on the concave side of bends made it necessary in extending this dike to place the new work 60 feet above the old and make it lap 40 feet. The dike was extended 73 feet to the line of rectification. The actual length of dike constructed was 113 feet of 3-row and 93 feet of 2-row, 50 feet of the latter being wing.

Pile-driving with a steam hammer was begun August 7 and completed August 12. The extension was entirely completed and the screening on the old work repaired by August 29. Cypress piles were used for the connection between the old and the new work, native oak for the first 60 feet of the extension, and white oak for the outer 53 feet and wing.

Dike 18 A.—As described in my last annual report, the work of extending Dike 18 A in accordance with the project of March 21, 1893, was attempted in May, 1893, by constructing a part of the usual 2-row dike for connecting the old work with the proposed extension. Before very much was accomplished work had to be suspended on account of the river rising over the dike. Work on the dike was resumed August 18, the part of the dike constructed in May repaired, and the dike extended. It laps the old work 70 feet, is situated 100 feet above it, and has a 43-foot wing.

The length of the 3-row dike in the extension is 343 feet, 70 feet of which is lap. White-oak piles were used for the outer 150 feet and wing, and cypress for the remainder of the work. The dike was completed September 1.

Dike 19 A.—This dike extends 1,471 feet from the main bank. It consisted of 1,890 feet of 3-row and 271 feet of 2-row dike, the latter being wings and the connections between the old and the new work where offsets were made. The discrepancy in length between the 3-row dike constructed and that of the dike's axis is accounted for by laps at offsets, amounting to 174 feet, and dike destroyed during floods, amounting to 245 feet. At the close of the last fiscal year the dike had been extended 1,100 feet from the shore, or to within 580 feet of the line of rectification.

Work on it was resumed August 12, 50 feet above and 68 feet back from the end of the old work. Good progress was made until August 19, when a sharp rise occurred. The rise brought considerable driftwood which lodged under and around the plant and among the piles, bending over and breaking off a number of the latter. By the 20th the river had risen to the top of the piles, making it necessary to move the plant from the dike for safety. The rise caused a suspension of work for five days, and the tangled mass of driftwood and piling made another offset in the dike necessary. The dike was completed September 13. With the exception of the outer 150 feet, for which white-oak piles were employed, large cypress piles were used for its construction. On account of the exposed position of the outer end of this dike to ice and driftwood a short wing was constructed above it in addition to the usual wing below. All of the piles were driven by steam hammers to penetrations of from 21 to 25 feet.

During a rise in April a field of driftwood accumulated above the dike. Shortly before the outer end was submerged by the rise the whole structure appeared to be in excellent condition. After the water fell it was discovered that the outer 207 feet had been entirely swept away. Soundings made subsequently on the line of the dike point to excessive scour as the probable cause of this occurrence.

Dike 26.—Jet pile-sinking was begun at dike 26 August 1, 727 feet from shore, shallow water preventing the pile-sinkers being operated any closer to the bank. By August 19 the dike had been carried to within 1,058 feet of the line of rectification, where a short wing was constructed and work suspended, as a further extension would have obstructed the steamboat channel. In the latter part of August the bar near the shore cut away and made it possible to sink piles in the gap at the shore end for 173 feet. In the latter part of September and early part of October the foot mat was constructed across the gap to the high bank and ballasted. Ir May the

piles were driven and braced for a distance of 151 feet at the north end of the gap. The remainder of the gap could not be constructed, as the low stage of water made it inaccessible to the plant. There still remains to complete the dike, to extend it 1,013 feet at the stream end and to construct 405 feet in the gap. Cypress piles were used exclusively for this dike.

Dike 27.—Work at dike 27 was begun July 22. As at that time the steamboat channel was situated close to the bank and crossed the proposed site of the dike, it was not feasible to carry the dike farther than 245 feet from the shore. This point was reached with the pile-driving August 2. Considerable difficulty was experienced during construction from the swift current.

On August 4 a drift log struck and broke five three-eighths-inch steel cables supporting the foot mat, which was under construction. This allowed the mat to be rolled up by the current against the piles, resulting in the outer four bents being overturned. Subsequently this part of the dike was reconstructed and a wing placed under the end.

Dike 28.—The construction of dike 28 was begun July 27. The dike was completed for a length of 1,316 feet from the shore end September 30. This was as far as it was possible to carry the work without obstructing the steamboat channel.

Cypress piles were used exclusively for this dike. About one-third of the piles were driven by a steam hammer and the remainder sunk by the water jet.

In jet pile sinking, proper penetrations could not be given with the $1\frac{1}{16}$-inch nozzle heretofore employed. Satisfactory results, however, were obtained by using two three-fourths-inch nozzles, one of which was fastened to the foot of the pile and the other moved up and down its side during the sinking. The difficulty in sinking piles with a single jet appeared to be caused in a measure by the light weight and buoyancy of the cypress, oak piles in the same locality being given good penetrations by one jet of the larger size. The shore end of the dike for a distance of 186 feet was double braced on account of its height.

The dike has still to be extended 874 feet to reach the line of rectification.

Dike 29.—Pile sinking was begun August 17 at a point 1,640 feet from the shore end of the dike, it not being practicable at that time to get the plant nearer shore on account of sand bars and shallow water.

By September 9, 190 feet of the dike next to shore and 903 feet at the outer end were completed, leaving a gap of 1,172 feet, on which it had been only possible to construct and ballast the foot mat. Work was resumed on this dike May 9, and the pile-driving and bracing constructed for 357 feet at the south end of the gap and 312 feet at the north end. The remaining 503 feet in the gap could not be constructed on account of the bar, which it crosses, being above water. The dike has also to be extended 210 feet.

Dike 34.—Dike 34 is 1,065 feet long and extends to the line of rectification. Its construction was begun September 2. It was not possible at that time to connect the dike with the bank on account of a foreshore of 120 feet, across which, however, the foot mat was laid and carried up the bank to S. H. W. The dike was completed, with the exception noted above, to the line of rectification September 30.

Three hundred feet of the pile structure, beginning 190 feet from the shore end, being high, was double braced.

As this dike is the head of a group and will be greatly exposed to running drift and ice, the largest piles were selected for its construction. White-oak piles were used for 200 feet at the stream end and the wing, and native oak for the rest of the dike. Most of the piles were placed with the jet. The penetrations obtained by this method in some instances not being satisfactory, a steam hammer was subsequently employed to complete driving the piles down. During a rise in the early part of March a great quantity of driftwood collected above the dike, which resulted in a breach of about 140 feet being made near the shore end. From soundings made in the breach in April, it appeared that a scour of from 12 to 16 feet had occurred and that the mattress had settled to the bottom. By this scour the penetration of the piles was reduced to less than 10 feet, making the unsupported lengths of the piles above ground from 26 to 30 feet.

Work was resumed on this dike May 2. The breach was repaired and the shore end of the dike constructed.

The original design for this dike was a 3-row structure. On account of the increased depth from scour, the reconstructed part across the breach and the part standing between it and the shore were made 4-row dike, and the largest and longest piles available used for the work. These piles were driven with a steam hammer and given penetrations of from 22 to 31 feet. The driving was very hard. A rise in the river, which occurred before the work was entirely completed, made it impossible to attach all the bracing.

Dike 35.—Construction on dike 35 was begun September 4 and suspended September 30. As at this time and during the remainder of the fall the width of the waterway at the dike was only equal to its proposed length, it was not practicable to extend the dike farther than 896 feet from its shore end.

The 140 feet adjoining the bank is 3-row dike, the 200 feet following 4-row, and the remainder 3-row. All the piles are double braced in the manner shown in figs. 2 and 3, Pl. II. Cypress piles were used except for the 120 feet at the outer end, which are native oak. All piles were driven with a steam hammer.

Continuous work was prevented on account of having to remove the hammer to dike 34 to complete the sinking of piles started with the jet.

Dike 36.—Pile sinking was begun at the shore end of dike 36 September 7. The bottom being hard and the penetrations unsatisfactory, a steam hammer was substituted for the sinker and the latter moved farther out on the dike, where the bottom was less resisting. Two-thirds of the piles were driven with the hammer. The driving was slow, 600 to 700 blows being required to give penetrations of 21 feet.

The piles used were principally native oak and were double braced.

Work was suspended September 30, the dike having been carried 732 feet from shore to the steamboat channel, and completed that far except attaching some of the screening, which was done October 12 to 14.

The total number of piles driven and jetted for dike work during the fiscal year amounted to 3,426, of which 324 were mooring piles.

The number of piles placed in each dike by the above methods and the average penetrations of each dike are given below:

Letter or number of dike	Number of piles, average penetration, and method of sinking.			
	Water jet.		Steam hammer.	
	Number.	Average penetration.	Number.	Average penetration.
		Feet.		*Feet.*
B	38	24		
C	14	25.7		
17A			57	22.7
18A			115	22.7
19A			304	21.9
20			163	25.5
21			110	22.6
21A	26	19.8	68	21.4
26	279	20.5	45	23.8
27	68	21.2	19	23.2
28	246	18	141	22.6
29	153	20	383	23.1
34	*219	19.1	125	25.2
35			301	22.1
36	78	20.7	141	21.3
Total	1,121	19.8	1,981	24.8

* Seventy-six piles, sunk to refusal by sinker, afterwards driven down by steam hammer.

The following table shows the extent of dike work completed:

Group.	Number or letter of dike.	Length in feet.				Total.	
		1-row.	2-row.	3-row.	4-row.	In dike.	In group.
Cedar City	B	....	175	....	....	175	
	C	....	95	....	....	95	
Total	....	....	270	....	....	....	270
Barkersville	20	....	[1] 50	497	....	547	
	21	....	[2] 97	306	....	403	
	21A	....	[3] 213	167	....	380	
Total	....	....	360	970	....	....	1,330
Osage	17A	....	[4] 93	113	....	206	
	18A	....	[1] 43	343	....	386	
	19A	....	[5] 155	[6] 700	....	855	
Total	....	....	291	1,156	....	....	1,447
Dodds Island	26	18	[7] 49	1,002	....	1,069	
	27	....	[1] 30	245	....	275	
	28	....	[1] 30	1,316	....	1,346	
	29	18	[1] 32	1,762	....	1,794	
Total	....	18	141	4,325	....	....	4,484
Hord	34	....	[8] 69	[9] 916	266	1,251	
	35	....	[1] 30	696	200	926	
	36	....	[1] 32	732	....	764	
Total	....	18	131	2,344	466	....	2,941
Total	....	18	1,193	8,795	466	....	10,472

[1] Wing.
[2] 50-foot wing, 47 feet connection between old and new work.
[3] 183 feet main dike, 30 feet wing.
[4] 43 feet main dike, 50 feet wing.
[5] 75 feet wing, 80 feet connection between old and new work.
[6] 38 feet washed out in August and 207 feet in March.
[7] 19 feet main dike, 30 feet wing.
[8] 48 feet wing, 21 feet shore end.
[9] 137 feet washed out, 107 feet of which were reconstructed as 4-row and 30 feet 3-row.

Detailed statement of driving mooring piles.

Letter or number of dike	Extent of work (number of piles).	Quantities of material.		Cost.		
		Native oak piles.	Coal.	Material.	Labor and subsistence.	Total.
		Lin. ft.	*Bushels.*			
19A	18	732	23	$82.47	$78.10	$160.57
21A	* 27	....	....	....	41.63	41.63
29	1	30	5	3.90	20.82	24.72
Total	46	762	28	86.37	140.55	226.92

* These 27 piles were sunk with a jet but had to be tapped down with the hammer in order to secure the proper penetration.

Average cost of driving one mooring pile, $3.06—. Total average cost of one mooring pile driven, $4.93+.

Detailed statement of sinking mooring piles.

Letter or number of dike.	Extent of work (number of piles).	Quantities of material.				Cost.		
		Native oak piles.	Cypress piles.	8 by ⅜ inch spikes.	Coal.	Material.	Labor and subsistence.	Total.
		Lin. ft.	*Lin. ft.*	*Pounds.*	*Bushels.*			
17A	8	276	....	5	20	$32.66	$23.24	$55.90
18A	14	486	....	10	20	55.59	40.93	96.52
19A	13	478	....	10	20	54.72	23.24	77.96
20	17	578	....	15	80	73.33	78.65	151.98
21	18	572	....	20	75	72.15	52.03	124.18
21A	27	1,088	....	30	80	129.10	72.78	201.88
26	33	1,136	....	28	70	133.00	99.83	232.83
27	17	504	....	15	30	58.93	55.05	113.98
28	43	1,358	90	32	76	170.20	136.91	307.11
29	38	1,367	....	35	75	158.91	54.22	213.13
34	32	1,140	....	30	75	134.12	81.94	216.06
35	37	1,342	....	35	110	160.63	123.06	283.69
36	32	1,192	....	22	75	139.59	118.45	258.04
Total	329	11,517	90	287	806	1,372.93	960.33	2,333.26

Average cost of sinking one mooring pile, $2.92—. Total average cost of one mooring pile sunk, $7.09+.

Detailed statement of driving dike piles.

Letter or number of dike.	Extent of work (number of piles).	Quantities of material.					Cost.		
		Native oak piles.	White oak piles.	Cypress piles.	Coal.	Wood.	Material.	Labor and subsistence.	Total.
		Lin. ft.	*Lin. ft.*	*Lin. ft.*	*Bushels*	*Cords.*			
17A	57	848	1,000	460	100	....	$337.36	$83.57	$420.93
18A	115	....	2,362	2,616	160	....	777.05	171.27	948.32
19A	304	....	2,770	10,022	241	....	1,861.75	356.76	2,218.51
20	163	3,508	2,608	....	241	....	855.42	159.04	1,014.46
21	119	2,530	2,531	....	210	....	732.10	162.60	894.70
21A	68	2,660	264	54	135	....	358.46	101.54	460.00
26	45	....	....	1,594	5	1	220.32	51.33	271.65
27	19	374	....	458	62	....	110.67	126.74	237.41
28	141	....	....	5,222	250	....	740.39	274.90	1,015.29
29	383	7,364	....	6,162	360	2.8	1,691.84	464.54	2,156.38
34	125	1,324	2,532	2,146	155	....	776.92	219.29	996.21
35	306	1,680	180	11,522	452	....	1,834.17	300.54	2,134.71
36	141	5,388	....	720	235	....	713.13	299.52	1,012.65
Total	1,986	24,676	14,247	40,976	2,606	3.8	11,009.58	2,771.61	13,781.22

Average cost of driving one dike pile, $1.40+. Total average cost of one dike pile driven, $6.94—.

Detailed statement of sinking dike piles.

Letter or number of dike.	Extent of work (number of piles).	Quantities of material.				Cost.		
		Native oak piles.	Cypress piles.	8 by ⅜ inch spikes.	Coal.	Material.	Labor and subsistence.	Total.
		Lin. ft.	*Lin. ft.*	*Pounds.*	*Bushels*			
B	38	1,308	....	30	75	$152.37	$108.38	$260.75
C	14	502	....	10	50	61.14	30.47	91.61
21A	26	920	....	25	60	108.19	69.72	177.91
26	279	10,280	....	228	338	1.165.47	202.13	1.367.60
27	68	2,510	96	52	72	296.17	94.24	390.41
28	246	....	8,602	190	320	1,212.37	585.77	1,798.14
29	153	5,443	....	136	170	616.29	212.44	828.73
34	219	8,210	....	175	220	924.28	288.18	1,212.46
36	78	3,394	....	55	110	384.11	185.02	569.13
Total	1,121	32,567	8,698	901	1,415	4,920.39	1,776.35	6,696.74

Average cost of sinking one dike pile, $1.58+. Total average cost of one dike pile sunk, $5.97+.

Detailed statement of weaving foot mat.

Letter or number of dike.	Extent of work.	Quantities of material.				Cost.		
		Brush.	⅜-inch wire cable.	⅜-inch clamps.	No. 10 wire.	Material.	Labor and subsistence.	Total.
	Sq. ft.	*Cords.*	*Feet.*	*Pounds.*	*Pounds.*			
17A	15, 015	93	2, 500	....	....	$176. 21	$122. 46	$298. 67
18A	27, 645	182	5, 000	....	....	345. 85	292. 26	638. 11
19A	49, 345	295½	8, 000	....	....	560. 40	559. 17	1, 119. 57
20	36, 591	228½	4, 000	....	....	412. 51	384. 56	797. 07
21	26, 692	200½	5, 700	....	....	382. 83	341. 05	723. 88
21A	30, 727	222	4, 300	....	....	404. 72	322. 46	727. 18
26	91, 421	655	12, 700	40	175	1, 203. 99	1, 058. 09	2, 262. 08
27	27, 723	148½	4, 500	6	7	287. 06	341. 03	628. 09
28	89, 155	659	14, 000	57	155	1, 227. 99	931. 37	2, 159. 36
29	129, 625	873½	15, 900	54	290	1, 597. 57	1, 281. 49	2, 879. 06
34	67, 381	388	11, 500	25	....	748. 04	773. 93	1, 521. 97
35	56, 959	311	11, 500	20	....	621. 34	619. 07	1, 240. 41
36	49, 093	302	7, 000	28	50	566. 13	533. 15	1, 099. 28
Total	697, 372	4, 558½	107, 000	230	677	8, 534. 64	7, 560. 09	16, 094. 73

Average cost of weaving 100 square feet, $1. 08+ ; total average cost of 100 square feet woven, $2. 31—.

Detailed statement of ballasting foot mat.

Letter or number of dike.	Extent of work.	Quantities of stone.	Cost.		
			Material.	Labor and subsistence.	Total.
	Sq. ft.	*Cu. yds.*			
17A	15, 015	96	$108. 54	$64. 12	$172. 66
18A	27, 645	218	246. 49	56. 17	302. 66
19A	49, 345	445	503. 15	254. 82	757. 97
20	36, 591	200	226. 13	56. 47	282. 60
21	26, 692	185	209. 17	144. 75	253. 92
21A	26, 727	236	266. 84	97. 44	364. 28
26	91, 421	691	781. 29	361. 24	1, 142. 53
27	14, 648	219	247. 62	170. 10	417. 72
28	89 155	648	732. 68	299. 90	1, 032. 58
29	128, 425	908	1, 026. 65	731. 80	1, 758. 45
34	67, 381	641	724. 76	360. 29	1, 085. 05
35	56, 959	493	557. 42	250. 05	807. 47
36	49, 093	412	465. 84	267. 44	733. 28
Total	679, 097	5, 392	6, 096. 58	3, 114. 59	9, 211. 17

Average cost of ballasting 100 square feet, $0.46— ; total average cost of 100 square feet ballasted, $1.36—.

Detailed statement of bracing dikes.

Letter or number of dike.	Extent of work.	Quantities of material.					Cost.		
		⅝-inch square iron.	¾-inch round bolts.	13/16-inch washers.	8 by ⅜ inch spikes.	Pine lumber.	Material.	Labor and subsistence.	Total.
	Lin. ft.	*Pounds.*	*Pounds.*	*Number.*	*Pounds.*	*Ft., B.M.*			
B	175	270	....	....	25	2, 910	$70. 47	$87. 62	$158. 09
C	95	90	....	....	10	1, 318	31. 29	18. 59	49. 88
17A	206½	475	....	....	35	5, 412	130. 29	37. 23	167. 52
18A	485	1, 100	....	....	85	11, 392	276. 40	94. 95	371. 35
19A	803½	2, 420	205	142	285	24, 455	602. 57	233. 72	836. 29
20	517	1, 052	....	....	115	14, 880	353. 97	132. 86	486. 83
21	402½	1, 211	....	....	90	10, 963	269. 01	90. 24	359. 25
21A	380½	825	....	....	90	9, 300	224. 76	81. 26	306. 02
26	1, 069	....	1, 813½	1, 335	178	26, 387	643. 83	408. 94	1, 052. 77
27	275	....	894	659	51	7, 830	201. 09	121. 57	322. 66
28	1, 346	....	3, 233	2, 352	302	26, 136	681. 28	372. 39	1, 053. 67
29	1, 794	....	3, 479	2, 360	305	38, 320	959. 27	476. 77	1, 436. 04
34	1, 113	....	2, 898	2, 067	263	27, 442	699. 84	300. 25	1, 000. 09
35	926	....	4, 043	2, 676	275	34, 008	878. 04	467. 60	1, 345. 64
36	764	....	3, 271	2, 489	178	23, 3[illegible]7	617. 68	484. 06	1, 101. 74
Total	10, 382	7, 443	19, 836½	14, 080	2, 287	264, 109	6, 639. 79	3, 408. 05	10, 047. 84

Average cost of bracing 1 linear foot of dike $0.33— ; total average cost of 1 linear foot of dike braced, $0.97—.

Detailed statement of lashing dikes.

Letter or number of dike.	Extent of work.	Quantities of material.	Cost.		
		⅜-inch wire cable.	Material.	Labor and subsistence.	Total.
	Lin. ft.	*Feet.*			
B	175	(*)	....	$17.93	$17.93
C	95	(*)	....	11.64	11.64
17A	206½	1,500	$14.29	55.42	69.71
18A	485	2,000	19.06	64.69	83.75
19A	314	5,000	47.65	42.36	90.01
20	547	3,000	28.59	14.23	42.82
21	402½	1,500	14.30	36.92	51.22
21A	380½	3,000	28.59	9.42	38.01
Total	2,605½	16,000	152.48	252.61	405.09

* The cable used for lashing dikes B and C was expended during the last fiscal year but was not attached until the beginning of this year.

Average cost of lashing 1 linear foot of dike, $0.10—; total average cost of 1 linear foot of dike lashed, 0.16—.

Detailed statement of screening dikes.

Letter or number of dike.	Extent of work.	Quantities of material.					Cost.		
		Brush.	30*d.* wire nails.	20*d.* wire nails.	8 by ⅜ inch spikes.	Pine lumber.	Material.	Labor and subsistence.	Total.
	Lin. ft	*Cords.*	*Pounds.*	*Pounds.*	*Pounds.*	*Ft., B. M.*			
B	37	1	....	10	....	113	$4.39	$4.49	$8.88
C	95	2	....	30	....	340	11.57	15.53	27.10
P	265	7	50	....	6	1,144	38.20	36.38	74.58
Q	431	9	60	....	9	1,584	51.56	48.64	100.20
17A	342½	15	75	....	12	680	41.63	26.50	68.13
18A	485	24½	90	....	80	408	53.04	109.81	162.85
19A	803½	53	285	....	20	1,760	132.67	235.85	368.52
20	547	8	110	....	5	816	33.79	46.84	80.63
21	402½	17½	102	....	15	1,360	61.54	76.88	138.42
21A	380½	27	83	....	....	1,156	71.80	60.22	132.02
26	918	36	125	125	42	1,232	93.06	99.31	192.37
28	1,276	43	160	160	140	1,965	124.75	132.84	257.59
29	340	15	40	40	55	1,349	57.74	99.56	157.30
34	987	42½	....	300	50	2,640	136.70	221.32	358.02
35	926	45	320	....	50	2,486	137.22	146.44	283.66
36	774	49½	280	150	80	2,497	148.11	162.82	310.93
Total	9,010	392	1,780	815	564	21,527	1,197.77	1,523.43	2,721.20

Average cost of screening 1 linear foot of dike, $0.17—; total average cost of 1 linear foot of dike screened, $0.30+.

Résumé of cost of dike construction on Osage division, first reach, for fiscal year ending June 30, 1894.

Dike B	$445.65
Dike C	180.23
Dike P	74.58
Dike Q	100.20
Dike 17A	1,253.52
Dike 18A	2,603.56
Dike 19A	5,629.40
Dike 20	3,751.09
Dike 21	1,750.87
Dike 21A	2,448.93
Dike 26	6,521.83
Dike 27	2,110.27
Dike 28	7,623.74
Dike 29	9,453.81
Dike 34	6,389.86
Dike 35	6,095.58
Dike 36	$5,085.05
Total net cost	61,518.17
Administration	2,485.00
Office and incidental expenses	3,538.53
Current care and repair of plant in service	2,523.21
Steamboat service	6,780.33
Surveys	3,065.12
Miscellaneous	360.12
	18,752.31
Total cost of dike construction	80,270.48

DIKE REPAIRS.

The following dikes were repaired, viz: Q, 2, 9, 10, 11, 13, 13A, 13B, 14, 17, 22, and 34. None of the repairs were extensive; they consisted, for the most part, of renewing the screening and strengthening the stream ends.

The details of repairs are as follows, viz: Repairing screening on dikes 2, 10, 11, 13, 13A, 14, and 17; slight repairs to bracing of dike Q; constructing 160 feet of 2-row dike above dike 9 to serve as an ice breaker; filling in the wing to S. L. W. with sectional mats and stone and extending it downstream 40 feet; replacing broken piles at stream end of dike 10 and strengthening the outer end with 2 clusters of piles which were lashed and braced to the dike; driving a cluster of 3 piles at the stream end of dike 11; driving 8 piles and rebracing outer end of dike 22, and reconstructing 137 feet of dike near the shore end of dike 34 referred to above. The work lost by high water and driftwood amounted to 470 linear feet, or about 4½ per cent of that constructed during the year.

The cost of dike repairs is given in the following statement:

Letter or number of dike.	Quantities of material													Cost.		
	Native oak piles (linear feet).	White oak piles (linear feet).	Cypress piles (linear feet).	Brush (cords).	Stone (cubic yards).	8 by ⅜ inch spikes (pounds).	30d. nails (pounds).	¾-inch round bolts (pounds).	12-inch washers (number).	No. 10 wire (pounds).	No. 12 wire (pounds).	Coal (bushels).	Pine lumber (feet, B. M.).	Material.	Labor and subsistence.	Total.
Q						10		37	136				300	$8.38	$51.28	$59.66
2							5			612	99			22.08	34.68	56.76
9	1,258	310	908	110	129		18	163				91		669.60	395.36	1,064.96
10	214		50	1			2	22				20		34.86	52.61	87.47
11	102			2			17	32					30	16.23	33.66	49.89
13 A							19							3.69	3.45	7.14
13 B	422			2			15	112					758	65.94	93.06	159.00
14				2			4	71					276	11.33	35.55	46.88
17	48			8			53							19.45	44.73	64.18
22			424			10		175	120			25	2,010	110.68	71.37	182.05
34			2,862			65		410	290			180	6,008	558.73	227.50	786.23
Total	2,044	310	4,244	134	129	85	133	1,023	546	612	99	316	9,382	1,520.97	1,043.25	2,564.22

Net cost of dike repairs		$2,564.22
Administration	$103.50	
Office and incidental expenses	147.40	
Current care and repair of plant in service	195.17	
Steamboat service	282.63	
Surveys	127.75	
		766.63
Total		3,330.85

RESULTS OF DIKE WORK.

The stage of water at all times during the year has been almost uniformly below the average. The highest stage attained was 1 to 3 feet below S. H. W. for four days in the early part of July and for about two weeks in the latter part of June.

The channel rectification accomplished described in former reports remained practically unchanged during the year.

The effects of new work constructed just prior to and since the close of the last fiscal year, although not quite as marked as in former years, are quite extensive and show considerable progress in the direction of the proposed improvement except of channel enlargement in front of dikes 21, 21 A, and 22. This progress would probably have been more pronounced if a higher stage of water had prevailed for a longer period.

The accretions around the dikes of the Cedar City group have built up to 3 or 4 feet, reducing the areas behind the dikes and below S. H. W. 20 to 25 per cent. The accretions behind dikes Q and Y have extended and raised. A fill of from 2½ to 5 feet has occurred in the old slough crossed by dike 1, and the accretions behind dikes 9, 10, and 11 have built up slightly. A part of these accretions is covered with a growth of willows.

The old channel above Barkersville, crossed by dikes 17, 18, 19, and 20, has filled up considerably, and the areas behind dikes 21, 21 A, and 22 reduced 20 to 30 per cent.

The middle bar in front of dikes 26, 27, and 28 has been almost entirely cut away, the areas behind the dikes in the old channel crossed by them reduced, and the proposed new channel along Cote Sans Dessein bluff partly developed.

To May 12 accretions 4 to 5 feet deep formed behind dike 29, about 20 feet deep behind dikes 34 and 35, and 5 or 6 feet deep behind dike 36.

No data is presented in the accompanying tables of the details of change in cross section for the dikes below dike 22, as they are still incomplete.

Data pertaining to the highest and lowest stages only at which the sections were sounded are given in Table III for dikes 1 to 14 inclusive, as data covering intermediate stages for these dikes have been published in reports of former years.

No exact comparison can be instituted between the percentages of area filled back for the different sections shown in Table III, as the sections were sounded on different dates and under different conditions.

The position of the rectified channel referred to in the tables is indicated on Pl. 1.

TABLE I.—*Areas of cross sections of the Missouri River in the vicinity of the dikes constructed in Osage division, first reach, from soundings made during the fiscal year ending June 30, 1894; also areas of scour and fill resulting from the dikes.*

Section.	Dates.	Gauge.	Areas below standard high water = 122 feet.			Fill or scour behind dikes.		Fill or scour in rectified channel.	
			Behind dikes.	In rectified channel.	Total.	Since last date.	Total.	Since last date.	Total.
		Feet.	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*	*Sq. ft.*
Dike B[1]	June 8, 1893	118.70	18,400	24,320	42,720	......	......	......	......
	July 18, 1893	116.60	17,520	28,640	46,160	+880	+880	−4,320	−4,320
	Aug. 9, 1893	110.85	14,960	26,328	41,288	2,560	+3,440	+2,312	−2,008
	Sept. 25, 1893	108.20	14,000	22,400	36,400	+960	+4,400	+3,928	+1,920
	Nov. 2, 1893	107.85	15,200	21,440	36,640	−1,200	+3,200	+960	+2,880
	June 14, 1894	117.15	14,480	25,280	39,760	+720	+3,920	−3,840	−960
Dike C[1]	June 8, 1893	118.70	19,280	23,820	43,100	......	......	......	......
	July 18, 1893	116.60	16,560	26,720	43,280	+1,720	+1,720	−2,900	−2,900
	Aug. 9, 1893	110.85	17,120	27,440	44,560	−560	+1,160	−720	−3,620
	Sept. 25, 1893	108.20	16,000	23,680	39,680	+1,120	+2,280	+3,760	+140
	Nov. 2, 1893	107.85	16,000	23,120	39,120	±0	+2,280	+560	+700
	June 14, 1894	117.15	15,740	22,720	38,460	+260	+2,540	+400	+1,100
Dike D[1]	June 8, 1893	118.70	24,000	25,300	49,300	......	......	......	......
	Aug. 9, 1893	110.85	27,360	27,360	54,720	3,360	−3,360	−2,000	−2,000
	Sept. 25, 1893	108.20	26,000	25,120	51,120	+1,360	−2,000	+2,240	+240
	Nov. 2, 1893	107.85	26,880	24,320	51,200	−880	−2,880	+800	+1,040
	June 14, 1894	117.15	21,920	26,080	48,000	+4,960	+2,080	−1,760	−720
Dike 16[1]	June 9, 1893	118.10	12,160	27,680	39,840	......	......	......	......
	July 13, 1893	110.	11,480	26,320	37,800	+680	+680	+1,360	+1,360
	Aug. 11, 1893	111.05	11,600	28,800	40,400	−120	+560	−2,480	−1,120
	Aug. 30, 1893	110.30	11,440	26,720	38,160	+160	+720	+2,080	+960
	Sept. 28, 1893	108.10	11,200	26,880	38,080	+240	+960	−160	[illegible]
	Oct. 20, 1893	107.70	11,200	26,240	37,440	±0	+960	+640	+1,440
Dike 17[1]	June 9, 1893	118.10	8,900	33,760	42,720	......	......	......	......
	July 13, 1893	116	6,400	31,120	37,520	+2,560	+2,560	+2,640	+2,640
	July 24, 1893	113.80	6,400	32,080	38,480	±0	+2,560	−960	+1,680
	Aug. 2, 1893	113.35	6,400	35,200	41,600	±0	+2.560	3,120	−1,440
	Aug. 16, 1893	110.55	6,400	34,960	41,360	±0	+2,560	+240	−1,200
	Aug. 30, 1893	110.30	6,400	33,840	40,240	±0	+2,560	+1,120	−80
	Sept. 28, 1893	108.10	6,400	32,560	38,960	±0	+2,560	+1,280	+1,200
	Oct. 20, 1893	107.70	6,400	30,960	37,360	±0	+2,560	+1,600	+2,800
Dike 18[1]	July 13, 1893	110	20,680	25,480	46,160	......	......	......	......
	July 24, 1893	113.80	20,120	25,200	45,320	+560	+560	+280	+280
	Aug. 2, 1893	113.35	21,600	26,800	48,400	−1,480	−920	−1,600	1,320
	Aug. 16, 1893	110.56	20,640	25,200	45,840	+960	+40	+1,600	+280
	Aug. 30, 1893	110.30	19,520	25,360	44,880	1,120	+1,160	−160	+120
	Sept. 28, 1893	108.10	19,760	25,360	45,120	−240	−920	±0	+120
	Oct. 20, 1893	107.60	19,520	25,280	44,800	+240	+1,160	+80	+200
Dike 19[1]	July 21, 1892	117.45	37,440	14,400	51,840	......	......	......	......
	June 16, 1893	114.55	31,280	18,800	50,080	+6,160	+6,160	−4,400	−4,400
	July 12, 1893	116.45	28,000	19,040	47,040	+3,280	+9,440	−240	−4,640
	July 24, 1893	113.80	30,390	19,840	50,230	−2,390	+7,050	−800	−5,440
	Aug. 2, 1893	113.25	31,430	20,880	52,310	−1,040	+6,010	−1,040	−6,480
	Aug. 16, 1893	110.55	30,150	21,000	51,150	+1,280	+7,290	−120	−6,600
	Aug. 29, 1893	110.45	30,710	21,240	51,950	−560	+6,730	−240	−6,840
	Sept. 28, 1893	108.10	30,790	20,960	51,750	−80	+6,650	+280	−6,560
	Mar. 19, 1893	110.75	27,800	20,400	48,200	+2,990	+9,640	+560	−6,000

+ The gain in area behind dike is caused by the deepening of the chute below dike 19 A, and by the washing away of the head of the middle bar. This will be better understood by referring to figs. 1 and 2, Pl. III.

TABLE I.—*Areas of cross sections of the Missouri River in the vicinity of the dikes constructed in Osage division, etc.*—Continued.

Section.	Dates.	Gauge.	Areas below standard high water=122 feet.			Fill or scour behind dikes.		Fill or scour in rectified channel.	
			Behind dikes.	In rectified channel.	Total	Since last date.	Total.	Since last date.	Total.
		Feet.	Sq. ft.	Sq. ft.	Sq. ft.	Sq. ft.	Sq. ft.	Sq. ft.	Sq. ft.
Dike 20 *	July 21, 1892	117.45	43,245	12,080	55,325	......	......	......	......
	Dec. 5, 1892	106.85	42,020	12,160	55,080	+325	+ 825	—80	—80
	Apr. 28, 1893	117.40	47,360	14,080	61,440	—4,440	—4,115	—1,920	—2,000
	May 30, 1893	116.55	46,880	11,200	58,080	+480	—3,635	+2,880	+880
	June 27, 1893	117.80	49,520	14,080	63,600	2,640	—6,275	—2,880	—2,000
	July 12, 1893	116.45	48,840	14,080	62,920	+680	5,595	±0	—2,000
	July 24, 1893	113.80	52,720	16,080	68,800	—3,880	9,475	—2,000	—4,000
	Aug. 2, 1893	113.35	53,450	16,000	69,450	—730	—10,205	+80	—3,920
	Aug. 16, 1893	110.50	52,800	16,400	69,200	+650	9,555	—400	—4,220
	Aug. 29, 1893	110.30	52,240	16,880	69,120	+560	—8,995	—480	—4,800
	Sept. 8, 1893	109.35	52,000	16,960	68,960	+240	—8,755	— 80	—4,880
	Sept. 28, 1893	108.10	52,160	17,480	69,640	160	—8,915	—520	—5,400
	Oct. 18, 1893	107.75	50,760	17,200	67,960	+1,400	7,515	+280	5,120
	Mar. 19, 1894	110.75	48,320	19,520	67,840	2,440	5,075	—2,320	—7,440
Dike 21 *	Sept. 2, 1892	109.75	19,005	12,585	......	......	......	......	......
	Oct. 10, 1892	107.60	18,880	12,810	......	+125	+125	—225	—225
	Apr. 28, 1893	117.80	18,880	14,640	......	±0	+125	—1,830	—2,055
	May 10, 1893	115.20	17,240	13,120	......	+1,640	+1,765	+1,520	—535
	June 27, 1893	117.70	18,200	11,200	......	—960	+805	+1,920	+1,385
	Aug. 2, 1893	113.25	17,840	15,120	......	+360	+1,165	—3,920	—2,535
	Oct. 18, 1893	107.65	15,760	17,720	......	+2,080	+3,245	—2,600	—5,135
	Mar. 20, 1894	110.65	13,360	17,760	......	+2,400	+5,645	—40	—5,175
Dike 21 A *	Aug. 1, 1893	113.85	18,160	10,800	......	......	......	......	......
	Aug. 28, 1893	110.55	16,920	10,200	......	+1,240	+1,240	+600	+600
	Oct. 18, 1893	107.65	17,600	13,200	......	680	+560	—3,000	—2,400
	Mar. 20, 1894	110.65	15,680	17,120	......	+1,920	+2,480	—3,920	6,320
	May 9, 1894	114.45	12,360	16,960	......	+3,320	+5,800	+160	—6,160
Dike 22 *	Sept. 2, 1892	109.75	18,152	20,675	......	......	......	......	......
	Dec. 5, 1892	106.75	17,485	21,362	......	+667	+667	—687	—687
	Apr. 28, 1893	117.30	12,480	19,600	......	+5,005	+5,672	+1,762	+1,075
	July 25, 1893	113.85	14,880	16,000	......	—2,400	+3,272	+3,600	+4,675
	Aug. 28, 1893	110.55	13,360	16,640	......	+1,520	+4,792	640	+4,035
	Oct. 18, 1893	107.65	13,760	15,760	......	—400	+4,392	+880	+4,915
	Mar. 20, 1894	110.65	13,680	16,560	......	+80	+4,472	—800	+4,115

*Besides the areas given as "behind dikes" and "in rectified channel," there are between the south line of rectification and the Osage chute dam, or the north bank of Dodds Island, from 26,000 to 28,000 square feet which are beyond the influence of the dikes to any great extent. The loss in channel area at dike 22 results from the encroachment of the middle bar.

+ The gain in area behind dike is caused by the deepening of the chute below dike 19 A, and by the washing away of the head of the middle bar. This will be better understood by referring to figs. 1 and 2, Pl. III.

TABLE II.

Section.	Period of observation.		Increase in channel area.
	From—	To—	
			Per cent.
Dike B[1]	June 8, 1893	June 14, 1894	3.9
Dike C[1]	...do...	...do...	—4.6
Dike D[1]	...do...	...do...	2.8
Dike 19[1]	June 16, 1893	Mar. 19, 1894	8.5
Dike 20[1]	June 27, 1893	...do...	38.6
Dike 21	Apr. 28, 1893	Mar. 20, 1894	21.3
Dike 21 A	Aug. 1, 1893	May 9, 1894	57
Dike 22	July 25, 1893	Mar. 20, 1894	4

[1] The increase of channel area noted for the several sections is the result of deepening.

TABLE III.—*Areas and dimensions of cross sections of rectified channel for different stages.*

Section.	Date.	Gauge.	Rectified channel below standard high water = 122 feet. Areas.	Fill or scour since last date.	Total fill back.	Per cent of section filled back.	Dimension and areas of rectified channel for different stages. Width.	Mean depth.	Maximum depth.	Area.
		Feet.	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*		*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*
Dike 13[1]....	July 18, 1893	116.60	28,640				1,108	20.4	23.5	22,622
	Aug. 9, 1893	110.85	26,328	+2,312	+2,312	8.1	1,085	13.9	16	12,206
	Sept. 25, 1893	108.20	22,400	+3,928	+6,240	21.9	1,075	6.7	10.5	7,220
	Nov. 2, 1893	107.85	21,440	+960	+7,200	21.5	1,070	5.5	10	5,961
Dike C[1]....	July 18, 1893	116.60	26,720				1,020	20.7	25.5	21,158
	Aug. 9, 1893	110.85	27,440	−720	−720	−2.7	1,015	15.9	18	16,174
	Sept. 25, 1893	108.20	23,680	+3,760	+3,040	11.4	985	9.8	13	9,708
	Nov. 2, 1893	107.85	23,120	+560	+3,600	13.5	980	9	12	8,878
Dike D[1]....	Aug. 9, 1893	110.85	27,360				1,160	12.4	17.5	14,400
	Sept. 25, 1893	108.20	25,120	+2,240	+2,240	8.2	1,140	7.9	13.5	9,078
	Nov. 2, 1893	107.85	24,320	+800	+3,040	11.1	1,140	7.2	11	8,246
Dike 1[1]....	July 14, 1893	115.45	31,920				1,190	20.2	29	24,011
	Oct. 20, 1893	107.70	24,400		+7,520	23.5	1,145	6.2	15	7,091
Dike 2[1]....	July 14, 1893	115.45	29,280				1,240	17.1	26	21,186
	Oct. 20, 1893	107.70	25,840		+3,440	11.7	1,220	6.7	13.5	8,881
Dike 3[1]....	Aug. 31, 1893	110.10	26,880				1,135	10.7	17	12,134
	Oct. 20, 1893	107.70	26,080		+800	2.9	1,060	9	13.5	9,560
Dike 9[1]....	Aug. 11, 1893	111.05	28,400				1,030	16.3	21.5	16,727
	Oct. 19, 1893	107.75	23,280		+5,120	18	1,025	8	16.5	8,310
Dike 10[1]....	Aug. 11, 1893	111.05	26,160				1,000	15	21	14,991
	Oct. 19, 1893	107.75	23,520		+2,640	10.1	980	9.3	17	9,177
Dike 11[1]....	Aug. 11, 1893	111.05	30,400				1,100	16.3	37.5	17,923
	Oct. 19, 1893	107.75	26,160		+4,240	13.9	1,040	10	31.5	10,395
Dike 13[1]....	July 13, 1893	116	31,200				1,230	19.3	26	23,805
	Oct. 19, 1893	107.75	27,440		+3,760	12	1,150	9	15.5	10,450
Dike 13 A[1]..	July 13, 1893	116	28,080				1,140	18.6	22.5	21,219
	Oct. 19, 1893	107.75	27,360		+720	2.5	1,115	9.9	15	11,030
Dike 13 B[1]..	July 13, 1893	116	27,520				1,075	19.5	25.5	20,965
	Oct. 20, 1893	107.70	24,880		+2,640	9.6	1,020	9.4	12	9,651
Dike 14.....	July 13, 1893	116	28,000				1,120	18.9	28.5	21,160
	Oct. 20, 1893	107.70	27,200		+800	2.9	1,060	10.7	19	11,327
Dike 16[1]....	July 13, 1893	116	26,320				1,125	17.2	23.5	19,345
	Oct. 20, 1893	107.70	26,240		+80	0.3	1,120	8.6	13	9,652

OSAGE CHUTE DAM.

After the completion of dikes 17 A, 18 A, and 19 A it was evident that their effect did not reach far enough below the last-named dike to entirely prevent the flow from the Missouri into Osage Chute. I was accordingly directed by you to construct the low-water dam, referred to under the heading of "Projects," between the head of Dodds Island and Osage Point, for the purpose of preventing a further development of the Osage Chute channel and of confining the whole discharge at low water to the proposed rectified channel in front of Barkersville.

The plan and sections of the dam are shown on Pl. IV and its location on Pl. I.

The distance between the shore ends on the line of the dam is 2,425 feet and the length of the dam proper 1,525 feet. Its general elevation corresponds to 110 feet on the Ewing gauge, or about 2 feet above S. L. W.

The foundation of the dam is a woven mattress sill 60 feet wide, of the standard type used for revetment, heavily ballasted. The sill extends across the entire opening from Osage Point to the head of Dodds Island, a distance of about 2,300 feet, at both of which points the bank is protected by revetment. A portion of the sill across the bar at the head of Dodds Island is at a higher elevation than that of the top of the dam and has a width of 50 feet. Its purpose is to prevent the dam being flanked.

The dam consists of one or more courses of continuous woven mattress, or frame mattress, ballasted, each succeeding course being narrower than the preceding one.

Before proceeding with the construction of the dam the bank of the Missouri River at Osage Point, for a distance of 500 feet, was protected by revetment. This work was begun October 3. At the same time 2 rows of piles, 15 feet apart in 10-foot bents, were driven or sunk across the waterway on the proposed line of the dam for the purpose of facilitating mattress construction and, after the mattress was sunk, of holding it in place until bedded.

The piles at the west end for a distance of 180 feet were driven so that their tops would be on a grade rising from the crest of the dam to the top of the bank. They were subsequently braced, forming a 2-row permeable dike. The remainder of the piles were driven so as to stand about 8 feet above the crest of the dam. After the completion of the dam they were cut down to its elevation. As soon as the revet-

ment mattress at Osage Point was completed and sunk the sill was begun at the Point and carried across the channel up on the opposite bar.

Three small mattress boats were used in its construction, one placed above the row of piles, one between, and one below them. It was generally sunk as rapidly as woven. To prevent the mattress from being rolled up or swept away by the current three-eighth-inch wire cables were attached to it and carried to mooring piles placed above the dam. These transverse cables were connected in the usual manner with three-eighths inch cables woven into each selvage and to two intermediate longitudinals of the same size. A scour of 2 or 3 feet occurred over a distance of about 250 feet near the middle of the chute ahead of the sill as it was carried forward.

The construction of a frame mat about 2 feet thick, to form the first course above the sill, was started about a week after the latter was begun. When this mattress was completed it was not considered practicable to lower about 250 feet of it situated near the middle of the channel on account of the swift current. That amount of frame mattress was therefore taken up and replaced by woven mattress. The other courses of mattress for this part of the dam are also of the woven type excepting the top course, which is a frame mattress.

After completing the mattress work the dam was thoroughly covered with stone riprap. The mattress sill was then extended over the bar to the head of Dodds Island, which was revetted for a distance of about 260 feet above and the same distance below the sill. The work was entirely completed, including the permeable dike at the west end, December 6.

During the construction of the dam about 150 feet near the east end settled from 2 to 3 feet, and about a month after its completion 70 feet immediately outside of the dike at the west end settled about 4 feet. In each instance the sunken portion was brought up to the level of the rest of the dam by filling in with brush and stone. The settling referred to was probably caused by parts of the sill not being sufficiently ballasted to cause it to sink to the bottom whenever rapid scour under the mattress occurred.

The discharge of the Missouri River, just before the construction of the dam was begun, amounted to about 27,500 cubic feet per second, 45 per cent of which flowed into Osage Chute. On the completion of the dam the whole discharge, excepting a very small proportion, estimated at 5 per cent, passed through the main channel of the river, which was deepened by scour 1 to 2 feet.

The extent and cost of the work are given in the following statement:

Class and extent of work and quantities of materials.	Price of materials.	Cost of each class of work and material.	Total.
Revetment at shore ends, 1,014 linear feet.			
Weaving 54,481 square feet of mattress:			
Labor and subsistence		$492.74	
340.5 cords brush	$1.63846	557.89	
12,000 feet ⅜-inch wire cable	.00953	114.36	
124 ⅜-inch clamps	.04	4.96	
			$1,169.95
Ballasting 54,481 square feet of mattress:			
Labor and subsistence		132.16	
495 cubic yards stone riprap	1.130672	559.68	
			691.84
Grading bank with hydraulic pile-sinker, 200 linear feet, 1,582 cubic yards:			
Labor and subsistence		94.84	
100 bushels coal	.127	12.70	
			107.54
Grading bank with shovels, 720 linear feet, 1,533 cubic yards:			
Labor and subsistence		154.06	
			154.06
Ballasting 26,820 square feet, 945 linear feet of graded bank with stone riprap:			
Labor and subsistence		208.83	
900 cubic yards stone	1.130672	1,017.60	
			1,225.83
Total cost of revetments			3,349.22
Sill across high bar 759 linear feet, 37,950 square feet of mattress.			
Labor and subsistence:			
Weaving matress		347.97	
Ballasting mattress		167.23	
Material:			
238 cords brush	1.63846	389.95	
393 cubic yards stone	1.130672	444.35	
8,200 feet ⅜-inch wire cable	.00953	78.15	
Total cost of sill			1,427.65

Class and extent of work and quantities of materials.	Price of materials.	Cost of each class of work and material.	Total.
Dam proper.			
Sinking 49 mooring piles			
Labor and subsistence		$82.63	
444 linear feet native oak piling	$0.10868	48.25	
81 linear feet cypress piling	.135703	110.73	
30 pounds 8 by ⅜ inch spikes	.02327	.70	
100 bushels coal	.127	12.70	
			$255.01
Sinking 147 anchor piles			
Labor and subsistence		246.96	
3,622 linear feet cypress piling	.135703	491.52	
130 pounds 8 by ⅜ inch spikes	.02327	3.02	
190 bushels coal	127	24.13	
			765.63
Driving 82 anchor piles			
Labor and subsistence		117 57	
2,735 linear feet cypress piling	.135703	371.15	
102 bushels coal	127	12 95	
			501.67
Constructing 2,655 linear feet, 141,040 square feet of woven mattress			
Labor and subsistence		1,293.24	
859.5 cords brush	1 63840	1,408.26	
29,780 feet ⅜ inch wire cable	00953	283 80	
			2,985.30
Ballasting 141,040 square feet of woven mattress			
Labor and subsistence		621.53	
1,800 cubic yards stone riprap	1 130672	2,035.21	
			2,656.74
Constructing 3,024 linear feet, 66,528 square feet of frame mattress			
Labor and subsistence		1,350.84	
1,803.5 cords brush	1.63840	2,954 96	
275 pounds 8 by ⅜ inch spikes	.02327	6.40	
575 pounds No. 8 wire	0309	17 77	
1,458 pounds No. 10 wire	.0309	45.05	
185 pounds ⅜ inch square iron	.01857	3.44	
			4,378.46
Ballasting 59,628 square feet of frame mattress:			
Labor and subsistence		787 84	
Taking up 250 feet frame mattress		111.52	
1,561 cubic yards stone riprap	1.130672	1,764.98	
			2,664.34
Total cost of dam proper			14,207.15
Bracing 160 feet of 2-row dike.			
Labor and subsistence		83.31	
2,432 feet, B. M., pine lumber	22.2953	54.22	
345 pounds ⅜ inch round bolts	02552	8.80	
217 wrought-iron washers	.00383	.83	
75 pounds 7 by ⅜ inch spikes	02367	1 78	
Total cost of bracing			148.94
Filling sink holes in dam:			
Labor and subsistence		142.87	
64 cords brush on stump	10	6 40	
80 cubic yards stone riprap	1 130672	90.45	
Total cost of filling sink holes			239.72
Résumé.			
Revetments at shore ends		3,340.22	
Sill across high bar		1,427.65	
Dam proper		14,207 15	
Bracing 2-row dike		148.94	
Filling sink holes		239.72	
Net cost			19,372.68
Miscellaneous.			
Administration		781.25	
Office and incidental expenses		1,116.59	
Current care and repair of plant in service		796.17	
Steamboat service		2,139 62	
Surveys		967 12	
Laying plank road on dam for hauling material		39.57	
Miscellaneous		113.64	
			5,956.96
Total			25,329.64

MURRAYS BEND REVETMENT.

The curvature of Murrays Bend is irregular. When the river is above a 3-10 stage the main flow follows the concave bank. At lower stages the channel leaves the bank in the upper part of the bend, crosses to the tow-head and returns to the main bank at the mouth of Cedar Creek.

For the period included between the surveys of April, 1879, and September, 1893, the area of erosion amounted to 1,091 acres, having an average width of 2,992 feet and a maximum width of about a mile. This is exclusive of the erosion of sand bar at the lower end of the bend, amounting to 151 acres. During 1893, prior to extending the revetment in September, the area of erosion in the lower 4,500 feet of the bend amounted to 20.5 acres, having an average width of 154 feet and a maximum width of 310 feet.

In pursuance of your instructions to proceed with the work of revetting the part of the bend below the revetment of 1893, a working party was organized and sent to the bend September 20, and a second one October 2.

The length of the bank which it was proposed to protect is 6,867 feet. The lower 6,000 feet is composed of fine sand, or sand with layers of loam, and the upper 900 feet of sand and occasional layers of gumbo. The latter part was graded to a slope of about 1 on 2½, the former to slopes of from 1 to 2½ to 1 on 2¾.

With the exception of 175 feet which, on account of shallow water, was inaccessible to the plant, the bank was graded by hydraulic pile-sinkers Nos. 4 and 6. Pile-sinker No. 4 is provided with a Knowles duplex pump with outside plungers 7 inches diameter by 11 inches stroke and 14-inch steam cylinders. The water connections between the pump and play pipe consisted of 68 feet of 4-inch wrought-iron pipe with two quarter and two eighth bends, and 36 feet of 4-inch rubber hose.

Pile-sinker No. 6 is provided with a Worthington duplex pump with inside plungers 7 inches diameter by 10 inches stroke and 12-inch steam cylinders. The actual stroke of this pump is 9 inches. The water connections between the pump and the play pipe consisted of 39 feet of 4-inch wrought-iron pipe with two quarter and two eighth bends, and 85 feet of 4-inch rubber hose. A 4-foot play pipe with ring nozzles was used with each pump.

The following are the results of hydraulic grading for the lower 5,667 feet of bank.

Details of hydraulic grading, Murrays Bend revetment, 1893.

[Worthington duplex pump, 7 by 10 by 12 inches.]

Date.	Diameter of ring nozzle.	Pump pressure.	Total theoretical pump discharge.	Actual time grading.	Height of bank.	Length of grade.	Total quantity of earth moved.	Earth moved by one cubic yard of water.
	Inches.	*Pounds.*	*Cu. yds.*	*Hrs. min.*	*Lin. feet.*	*Lin. feet.*	*Cu. yds.*	*Cu. yds.*
Oct. 12	15/16	110	430	6 30	16½	100	316	0.73
Oct. 13	15/16	110	430	6 30	17½	140	477	1.11
Oct. 14	15/16	110	430	6 30	18	160	464	1.08
Oct. 16	15/16	117	441	6 40	16	150	1,040	2.36
Oct. 17	15/16	116	439	6 38	15	178	1,090	2.48
Oct. 18	15/16	117	432	6 32	16	160	864	2.00
Oct. 19	15/16	116	441	6 40	16	167	809	1.83
Oct. 20	15/16	119	440	6 39	17	125	661	1.50
Oct. 21	15/16	117	154	2 20	17	50	254	1.65
Oct. 25	15/16	116	374	5 39	17	138	502	1.34
Oct. 26	15/16	118	424	6 25	16	204	646	1.52
Oct. 27	15/16	120	454	6 52	20	150	915	2.01
Oct. 28	15/16	117	453	6 51	20	110	1,056	2.33
Oct. 30	15/16	120	452	6 50	20	126	1,378	3.05
Oct. 31	15/16	120	460	6 57	20	108	922	2.00
Nov. 1	15/16	124	481	7 06	20	136	1,156	2.40
Nov. 2	15/16	122	458	6 55	19	136	1,388	3.03
Nov. 3	15/16	125	485	7 00	19	120	1,200	2.47
Nov. 4	15/16	125	493	7 07	18	110	990	2.01
Nov. 6	15/16	125	369	5 20	18	119	902	2.44
Nov. 7	15/16	125	199	2 52	15	138	750	3.76

Details of hydraulic grading, Murrays Bend revetment, 1893—Continued.

[Knowles duplex pump, 7 by 10 by 14 inches.]

Date.	Diameter of ring nozzle.	Pump pressure.	Total theoretical pump discharge.	Actual time grading.		Height of bank.	Length of grade.	Total quantity of earth moved.	Earth moved by one cubic yard of water.
	Inches.	*Pounds.*	*Cu. yds.*	*Hrs.*	*min.*	*Lin. feet.*	*Lin. feet.*	*Cu. yds.*	*Cu. yds.*
Oct. 9	1⅛	100	554	7	16*	16	80	306	.55
Oct. 10	1⅛	100	517	6	47	16	80	284	.55
Oct. 11	1¼	100	575	7	20	16	120	435	.76
Oct. 12	1⅛	100	541	7	06	16	170	526	.97
Oct. 13	1	123	518	7	12	16	160	395	.76
Oct. 14	1	110	475	7	02	16	70	319	.67
Oct. 16	1	110	473	7	00	16	90	766	1.64
Oct. 17	15/16	120	503	7	00	16	100	585	1.16
Oct. 18	15/16	120	476	7	03	16	170	770	1.62
Oct. 19	15/16	120	484	7	10	16	125	517	1.07
Oct. 20	15/16	120	479	7	06	16	125	453	.95
Oct. 21	15/16	120	494	7	19	16	200	728	1.47
Oct. 25	15/16	123	194	2	47	15	50	274	1.41
Oct. 26	15/16	125	517	7	25	15	130	606	1.17
Oct. 27	15/16	125	518	7	34	15	135	700	1.35
Oct. 28	15/16	125	529	7	35	15	150	1,003	1.90
Oct. 30	15/16	125	421	6	21	16½	66	383	.91
Oct. 31	15/16	125	457	7	00	18	90	870	1.90
Nov. 1	1	115	480	7	07	16	100	972	2.02
Nov. 2	1	125	488	7	00	16	85	812	1.66
Nov. 3	1	125	516	7	39	17	160	1,283	2.48
Nov. 4	1	125	518	7	40	16	145	1.367	2.64
Nov. 6	1	125	453	6	43	15	170	1,396	3.08
Nov. 7	1	125	221	3	10	15	65	508	2.39
Total			20,140	294	15		5,667	34,038	1.69

Résumé of hydraulic grading.

Pump.	Bank graded.	Time of grader in service.	Time actually grading.		Bank graded.	Bank graded by one cubic yard of water.	Earth graded in one day of 8 hours.	Bank graded in one day of 8 hours.	Average cost of grading 1 cubic yard.
	Lin. ft.	*Hrs.*	*Hrs.*	*min.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Lin. ft.*	
Knowles duplex	*2,002	128	113	42	8,851	1.100	553.2	125.12	$0.036328
Worthington duplex	†2,825	160	130	53	17,780	2.034	889.0	141.25	.025747
Knowles duplex	‡840	56	49	40	7,407	2.209	1,058.1	120.00	.018011

* Sandy loam, with streaks of gumbo. † Sand and sandy loam.
‡ Principally very fine sand; top soil sandy loam.

The mattress extends to S. L. W. The width of the upper 3,527 feet is 64 feet and of the lower 3,310 feet from 68 to 72 feet. It is woven by three gangs in 4 sections, the lengths of which are 3,163, 2,051, 1,365, and 633 feet. Laps of from 75 to 80 feet were made at each of the contiguous sections of mattress, also at the junction of the upper section with that of the revetment of 1893. The shore edge of the mattress was woven around anchor piles, placed 10 feet apart, and thoroughly covered with stone ballast. About 0.57 cubic yards of stone were used for ballasting 100 square feet of mattrass. The mattress was completed October 28. The upper bank was ballasted to S. H. W. with 0.9 of a cubic foot of a stone riprap per square foot. On account of the sandy character of the bank in the lower 3,500 feet of the bend, a covering of straw from 1 to 2 inches thick was laid on the face of the slope up to a half stage before placing the ballast. The ballasting of the bank was completed November 18.

The following statement shows the cost and extent of the work in detail:

Class and extent of work and quantity of material.	Price of material.	Cost of each class of work and material.	Total.
Sinking 677 anchor piles:			
Labor and subsistence	....	$612.57	
11,214 linear feet native oak piling	$0.10868	1,218.74	
6,043 linear feet cypress piling	.135703	820.05	
136 pounds 8 by ⅜ inch spikes	.02327	3.16	
200 pounds 7 by ⅜ inch spikes	.02367	4.73	
409 bushels coal	.127	51.95	
Weaving 7,172 linear feet, 479,300 square feet, of mattress:			$2,711.20
Labor and subsistence	....	3,030.03	
2,870.5 cords brush	1.63846	4,703.20	
127,560 feet of ⅝-inch wire cable	.00953	1,215.65	
9,150 pounds ¾-inch wire cable	.04	366.00	
1,012 ⅝-inch clamps	.04	40.48	
256 ⅝-inch clamps	.08	20.48	
240 pounds No. 10 wire	.0309	7.42	
Ballasting 479,300 square feet of mattress:			9,383.26
Labor and subsistence	....	1,021.20	
2,723.5 cubic yards stone riprap	1.130672	3,079.39	
Grading 6,692 linear feet of bank, 1,613 cubic yards, with shovels:			4,100.59
Labor and subsistence	....	570.04	
Grading 6,692 linear feet of bank, 35,563 cubic yards, with hydraulic pile sinkers:			570.04
Labor and subsistence	....	820.91	
1,416.25 bushels of coal	.127	179.86	
Ballasting 6,867 linear feet, 285,484 square feet, of graded bank:			000.77
Labor and subsistence	....	1,562.43	
9,279.5 cubic yards stone riprap	1.130672	10,492.07	
			12,054.50
Net cost	....	....	29,820.36
Miscellaneous:			
Administration	....	1,204.61	
Office and incidental expenses	....	1,715.26	
Current care and repair of plant in service	....	1,223.05	
Steamboat service	....	3,286.80	
Surveys	....	1,485.90	
Incidentals	....	174.57	
			9,090.19
Total	....	....	38,910.55

In the spring of 1894 about 11,000 square feet of the upper bank protection were damaged during high stages of water by wave action and surface drainage. This was repaired in May, by removing some of the stone ballast and fairing up the face of the slope by a filling of straw and brush. The cost of the repairs amounted to $125.58.

CONSTRUCTION MATERIAL.

The quantities of construction material on hand, procured and disposed of, also the cost per unit, are shown in the following statement. The average cost is for the year: it includes the purchase price and all expenses of every kind, excepting towage incurred in inspecting, handling and receiving each kind of material; also the value of the material on hand at the end of the last fiscal year:

Statement.

Class of material.	On hand June 30, 1893.	Procured during fiscal year ending June 30, 1894.	Expended during fiscal year ending June 30, 1894.	On hand June 30, 1894.	Cost per unit.
Brush ... cords	212	11,059.5	11,271.5	....	$1.63846
Stone ... cubic yards	1,112	21,945	22,758.7	298.3	1.130672
⅝-inch wire cable ... feet	95,780	205,060	300,840	....	.00953
White-oak piles ... linear feet	46,254	....	14,597	31,657	.17008
Native oak piles ... do	15,750	96,731	94,008	18,473	.10868
Cypress piles ... do	29,998	255,000	67,450	217,548	.135703
8 by ⅜ inch spikes ... pounds	1,465	15,000	4,759	11,706	.02327
7 by ⅜ inch spikes ... do	900	5,400	275	6,025	.02367
30*d* wire nails ... do	645	4,800	1,930	3,515	.02155
20*d* wire nails ... do	1,255	1,000	827	1,428	.0235
⅝-inch square iron ... do	2,850	5,039	7,889	....	.01857
No. 16 wire ... do	3,748	17,096	15,668	7,176	.02557
No. 10 wire ... do	5,989	....	3,277	2,712	.0309
Yellow pine lumber ... feet, B. M.	267,874	375,216	301,957	341,133	.0222953
Coal ... bushels	1,400	63,956.25	65,062.75	293.5	.12958
Wood ... cords	....	35.8	17.8	18	3.359
¾-inch round bolts ... pounds	....	37,218	21,204.5	16,013.5	.02552
13/16-inch washers ... number	....	24,000	14,843	9,157	.00383

The brush was procured by hired labor and towed an average distance of 37 miles.

The other materials were procured by purchase in the open market. The number of cubic yards of stone furnished at different points was as follows, viz: 8,388 on the river bank in Murrays Bend; 1,681 on barges at Jefferson City; 1,908 on barges 1 mile above Jefferson City; 5,490 at the mouth of Moreau Creek, of which 3,753 were on barges and 1,737 on the river bank; 803 on the river bank at the mouth of the Osage River, and 3,675 on barges one-half mile below Bonnots Mill, Mo.

All the native oak piles were delivered on barges as follows, viz: 8,960 linear feet in Moreau Creek; 77,754 linear feet at Bonnots Mill, and 10,017 linear feet on the work.

The cypress piles were delivered on the ground at the Bonnots Mill yard. The following is a brief synopsis of the specifications under which they were furnished:

"Piles to be sound, live, fresh-cut red and yellow cypress; bark removed; limbs cut off close; butts sawed off square; taper gradual; no button heads, short bends and twists, or numerous or rotten limbs; not over 1 inch out of wind in 4½ feet of length; point diameters from 8 to 11 inches; butt diameters of piles 30 to 40 feet long, from 13 to 19 inches; 40 to 50 feet long, 16 to 19 inches, and over 50 feet long, 16 to 19½ inches. No pile to have less than 7 inches of heart at point; piles 13 to 14 inches butt diameter, 1-inch sap ring allowed; 14 to 18 inches butt diameter, 1½-inch sap ring, and over 18 inches, 2-inch sap ring." Some of the piles over 40 feet long having only 12 inches of heart at the butt were accepted on account of being in other respects of superior quality. The lumber for dike bracings is all heart long, leaf yellow pine and was delivered on the railroad track at Bonnots Mill.

STEAMBOAT SERVICE.

The towing of material, moving of plant, and other steamboat service was performed by the steamers *Wm. Stone*, *Melusina*, *Dorris*, *John R. Hugo*, and *Pin Oak*. The *Hugo* and *Pin Oak* were chartered in the fall when the low stage of water made it necessary to have boats of very light draft. The charter price, without fuel, of the former was $40 and of the latter $25 per diem. In conducting spring operations the *Melusina* was employed for about five weeks, the *Dorris* for nine days, and the *John R. Hugo* for about two days. The total cost of steamboat service amounts to $21,429.71.

Besides the towing shown in the accompanying table the *Wm. Stone* performed the following service, at a cost of $2,383.07, viz: Raising two sunken barges and two pile-sinker cross boats; pulling 3 pieces of plant off the ways and getting 1 stranded barge afloat; pulling snags in Murrays Bend; assisting the sunken steamer *Patience*; washing out deposit at the foot of the launching ways, and working at washing out the Bakersville crossing.

The following statement shows the extent, cost, and classification of service performed by each boat for the first half of the fiscal year:

Statement.

Name of boat.	Classified service in ton miles.								Number of days employed.	Cost per diem.	Cost per ton mile.	Coal, per ton mile.
	Brush.	Stone.	Piling.	Miscellaneous.	Plant.	Empty barges.	Dispatch service.	Total.				
Wm. Stone	167,701	3,700	7,013	24,280	9,757	69,712	32,850	315,013	70 7/12	$101.7685	$0.02282	0.056029
Doris	11,573	24,750	12,867	6,905	6,252	25,015	29,115	116,477	136	19.0096	.022196	.054084
Melusina	5,342	13,785	12,162	11,150	12,014	22,181	27,945	104,579	151	21.3077	.030766	.073203
Pin Oak	29,643	11,830	2,989	693	1,873	32,354	7,740	87,122	72	28.4122	.023894	(*)
John R. Hugo	141,471	697	5,084	1,848	24,447	67,391	2,970	243,908	58	51.6380	.012279	.021783
Total	355,730	54,762	40,115	44,876	54,343	216,653	100,620	867,099	......	....	....	....

* Used coal and wood, principally the latter.

NOTE.—The columns headed "brush," "stone," "piling," and "miscellaneous," are exclusive of the weight of the carrying barges and the towboats; that headed "miscellaneous" includes plant lumber and other plant material; also coal, provisions, etc. Empty barges are barges sent to stone quarries, brush patches, or pile yards for material; plant covers the moving of plant between different localities. The weight and travel of the towboat are not included in any of the computations.

CONSTRUCTION, REPAIR, AND CARE OF PLANT.

Plant construction.—A third set of eight storage tracks 600 feet long was constructed at the boat yard to accommodate the new plant, and the switch track extended 127 feet to connect with it.

Ten frame barges were constructed in accordance with plans prepared at your office. These barges are 100 feet 6 inches long by 25 feet wide by 5 feet 10 inches deep amidships. The frames, cavils, planksheers, and grub streaks are white oak and the other parts long-leaf yellow pine. The latter material was used as it was not possible to get sufficient supply of oak expeditiously or at a reasonable price. The barges were constructed in two lots of 5 each. The first lot was constructed during the summer on the storage tracks, the second lot in the fall on temporary ways erected for the purpose on the bar in front of the woodworking mill. Two of the latter barges were transferred to the Gasconade division. The following statements show the cost of labor and material for each lot of barges:

First lot of 100-foot barges:		
36,285 feet, B. M., white oak	$1,359.11	
153,832 feet, B. M., long-leaf yellow pine	3,372.26	
13,514 pounds iron, assorted sizes	253.28	
8,845 pounds spikes, assorted sizes	231.74	
2,141 pounds nails, assorted sizes	47.64	
12 pounds white lead	.80	
850 pounds mineral paint	11.33	
118 gallons linseed oil	58.11	
35 carriage bolts	.52	
6,037 washers	23.73	
142 pounds washers	7.10	
3,817 pounds oakum	225.01	
223 pounds sheet lead	10.78	
164 pounds nuts	5.42	
Cost of material		$5,606.83
Machine boat, labor, subsistence, and supplies	307.34	
Sawmill, labor, subsistence, and supplies	547.55	
Ship carpenter, labor and subsistence	7,875.71	
Calkers, labor and subsistence	1,377.49	
Common labor	511.08	
Launching, labor and subsistence	159.82	
Handling and inspecting lumber and material	775.57	
Cost of labor, subsistence, and supplies		11,554.56
Total cost		17,161.39
Cost per barge		3,432.28
Second lot of 100-foot barges:		
36,285 feet, B. M., white oak	1,359.11	
153,832 feet, B. M., long-leaf yellow pine	3,372.26	
13,452 pounds iron, assorted sizes	272.27	
8,282 pounds spikes, assorted sizes	216.99	
2,365 pounds nails, assorted sizes	52.62	
13 pounds white lead	.89	
510 pounds mineral paint	6.80	
155 gallons linseed oil	76.31	
11 carriage bolts	.16	
5,718 washers	22.47	
245 pounds washers	12.25	
3,142 pounds oakum	185.22	
138 pounds sheet lead	6.67	
Cost of material		5,584.02
Machine boat, labor, subsistence, and supplies	267.11	
Sawmill, labor, subsistence, and supplies	590.26	
Ship carpenter, labor and subsistence	6,251.03	
Calkers, labor and subsistence	1,461.39	
Launching, labor and subsistence	225.03	
Common labor	817.03	
Handling and inspecting lumber and material	775.58	
Cost of labor, subsistence, and supplies		10,487.46
Total cost		16,071.48
Cost per barge		3,214.30

The cost of the first lot was made greater than that of the second by the failu dealers to furnish lumber on time, and also for the reason that the storage tra were not as convenient for construction as the ground in front of the mill. latter site, however, being overflowed by the June rise, was not sufficiently d out to be used for such a purpose till after the first lot of barges was completed.

The cabin of the office boat was completed, 20 horse capstans constructed, 2 buildings for storing bolts and spikes erected, one at Bonnot's mill and the othe Ewing's boat yard, and a platform for storing coal at the former point. Du the fiscal year the number of 100-foot barges was increased by 12, 8 of which constructed on the work, as mentioned above, and 4 by contract on the Ohio Ri There were also received from the Ohio River eleven 16 by 64 foot barges. is estimated that these accessions to the plant will not more than replace barges that will become entirely unfit for service during the ensuing fiscal year.

Plant repairs.—The work of lengthening the steamer *Doris*, for the purpos lessening her draft, was completed and the boat put in service in July. cabins and machinery were moved from 4 old pile-sinker hulls and set up on t constructed during the last fiscal year. Two sets of 52-foot leads framed last y were erected and two sets shifted from old cross-boat hulls to the new ones. Ex sive repairs were made to the hull of hydraulic grader No. 5 and a set of ste hammer leads framed and erected on the boat. The old steam-hammer leads wh had formerly been on No. 5 were erected on No. 8, and 3 skiffs reconstructed.

The repairing and launching of plant required for spring work were begun A 9 and completed April 30. Twenty-five hulls were calked, repaired, and launc This work was delayed by a fluctuating stage of water and rainy weather. following are the quantities of the principal plant material used for construc and repairs:

White pine lumber	feet, B. M..	16,
Short-leaf yellow pine lumber	do....	24,
Long-leaf yellow pine lumber	do....	388,
White oak lumber	do....	82,
Nails, assorted	pounds..	7,
Mineral paint	do....	2,
Yellow ocher	do....	
Red lead	do....	
White lead	do....	2,
Sheet lead	do....	
Spikes, assorted	do....	18,
Oakum	do....	9,
Norway iron, assorted	do....	
Common iron, assorted	do....	37,
Steel, assorted	do....	
Nuts, assorted	do....	
Sheet iron	do....	1,
Pipe, assorted	feet..	3,
Common yellow grease	barrels..	
Canvas	yards..	
Linseed oil	gallons..	
Turpentine	do....	

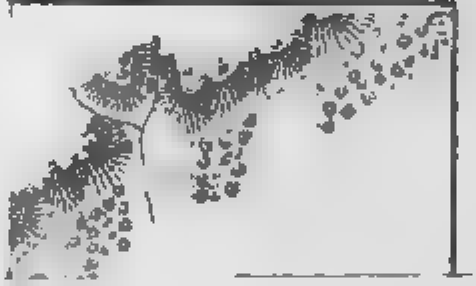
In carrying on plant construction and repairs, the woodworking mill was constantly employed from July 6 to November 6. During this period 888,000 squ feet of lumber were surfaced, 75,000 linear feet sawed, and other miscellaneous w done.

Care of plant.—The plant that was in the river and not in service at the time of June rise was kept at Boggs Creek. When field work was suspended in the fall floating plant of this division consisted of 107 hulls. Of this number, 7 pieces, 4 small survey quarter boats, 1 hydraulic grader, and 2 office boats had been on the ways during the year. Of the remaining 100 pieces, 96 were pulled out the storage tracks and 4 pieces, viz, 2 old mattress boats, 1 office boat, and 1 foot barge were left in the river, the former two under Dike 10, the office boat Dike 9, and the barge with the towboat *Wm. Stone*, which was laid up under the at the mouth of Osage River.

The pulling out and storing of plant was begun November 13 and comple December 9.

During the suspension of field operations 6 men were employed to watch and for the plant, 4 at the boat yard and 2 on the *Wm. Stone*. On the completion spring work the floating plant that had been in service was laid up in the rive Ewings, and the calking of the bottoms of the hulls stored on the tracks driven and the hulls flooded to the top of the floor beams.

PLATE I.



I RIVER COMMISSION,

IVISION, FIRST REACH.

ng dikes adopted for works

ig fiscal year of 1894.

Scale

10 20 feet.

, screw ends.

eport for 1894, of Sam! H. Yonge, Dir. Engr

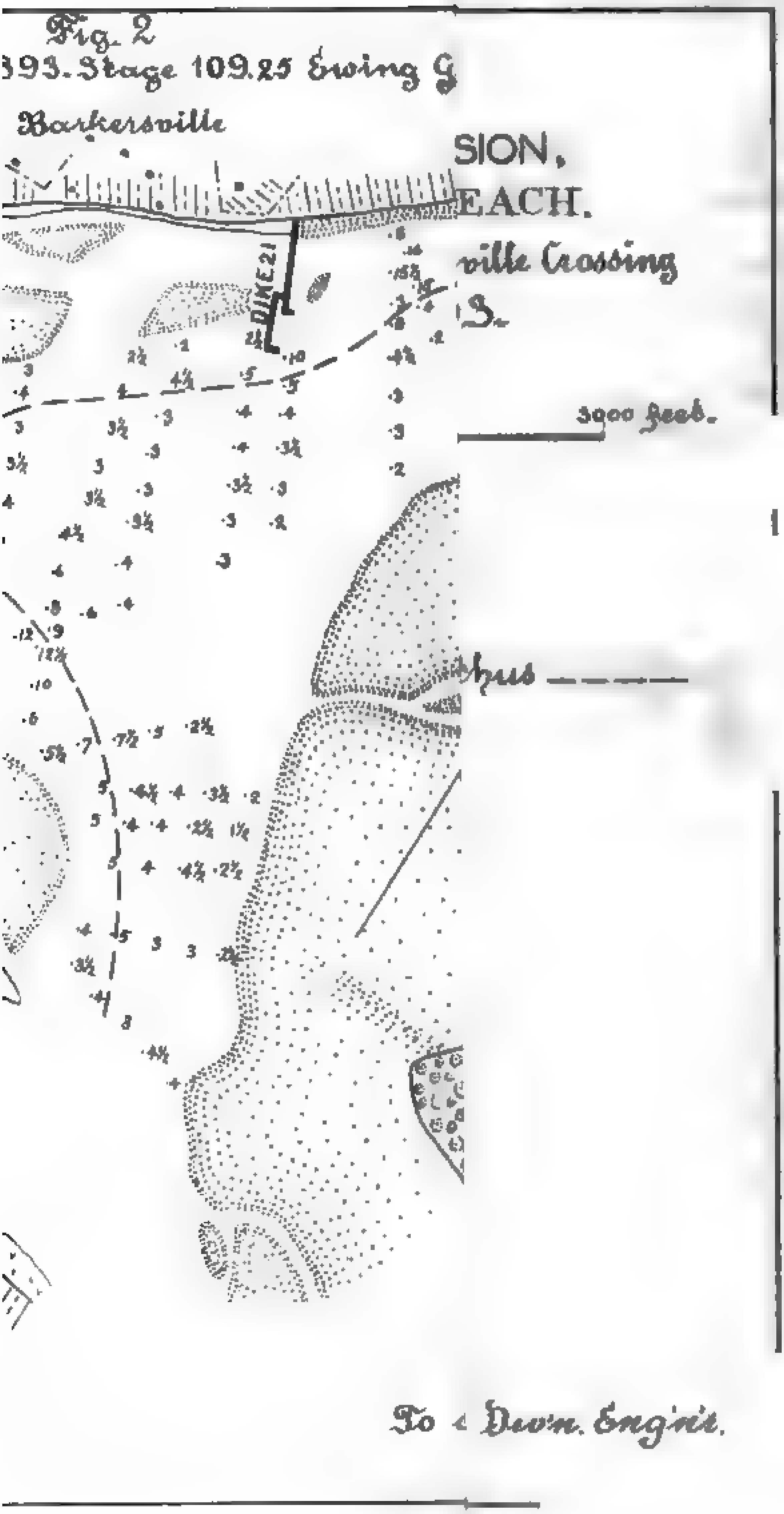
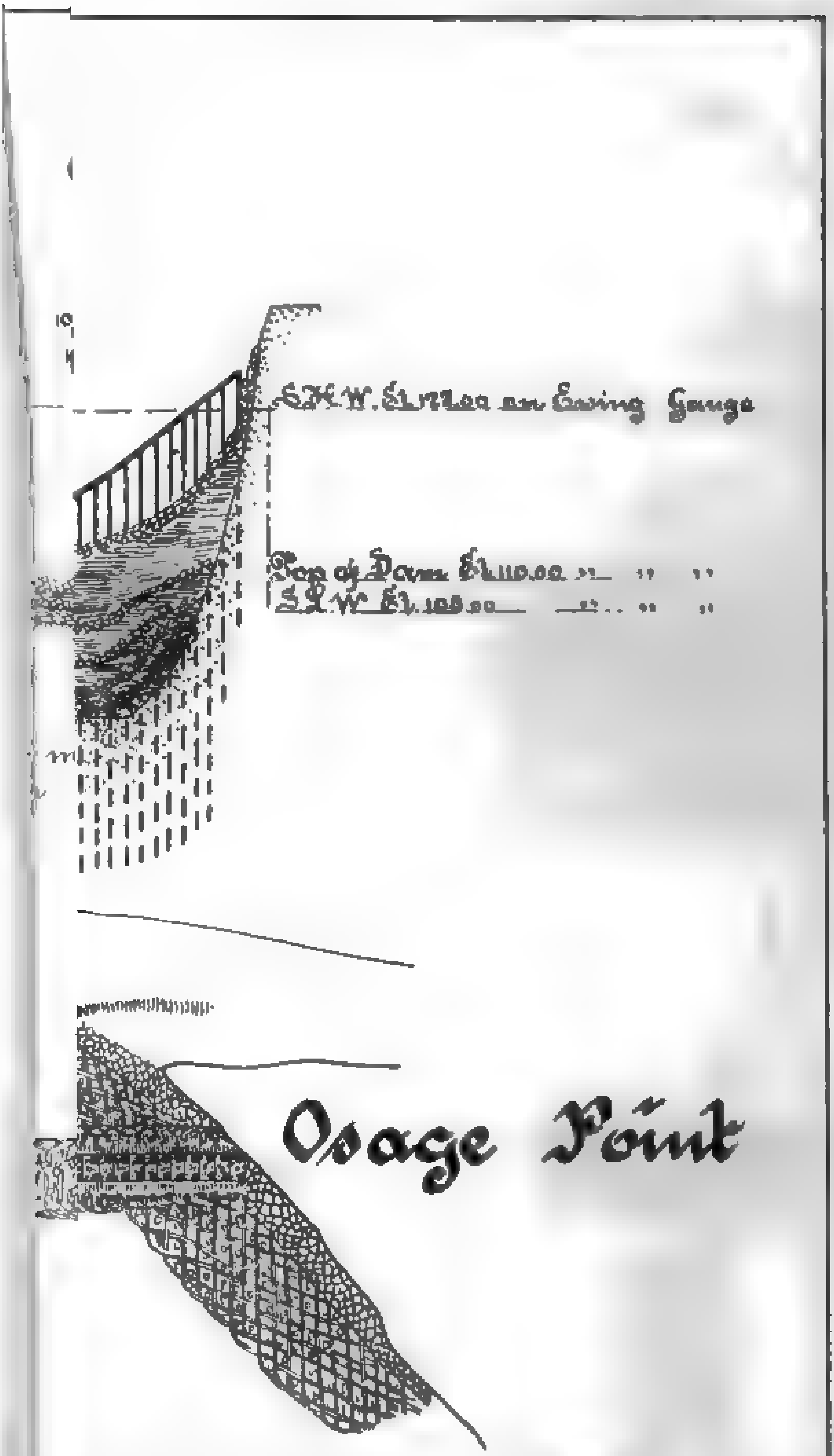
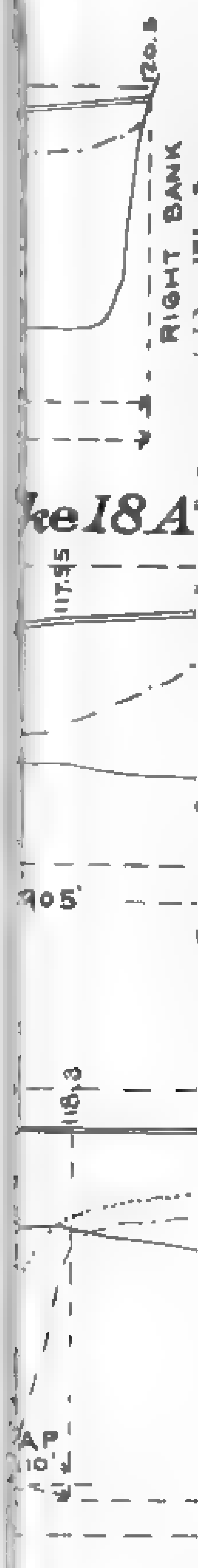


Fig. 2
393. Stage 109.25 Ewing G
Barkersville
SION,
EACH.
ville Crossing
S.
DIKE 21
3900 feet.
hus
To Divn. Engine.



1894, of S.H.Yonge, Div. Eng'r.

MMISSION,
ST REACH.
Sections of River.



500 1000 feet

40 feet

sounded between Dikes 18 and 19.
" " " 19 " 20.
nded on line of dikes.
shown thus
" "

, of S. H. Yonge, Div. Eng'r.

VER COMMISSION,

ION, FIRST REACH.

Cross-Sections of River.

cales:

500 1000 feet

20 30 40 feet

21 were sounded on line of dike.

A " " " " " "

s sounded between Dikes 26 and 27.

ar of 1893 shown thus

" 1894 " "

1894, of Saml. H. Yonge, Div. Engr.

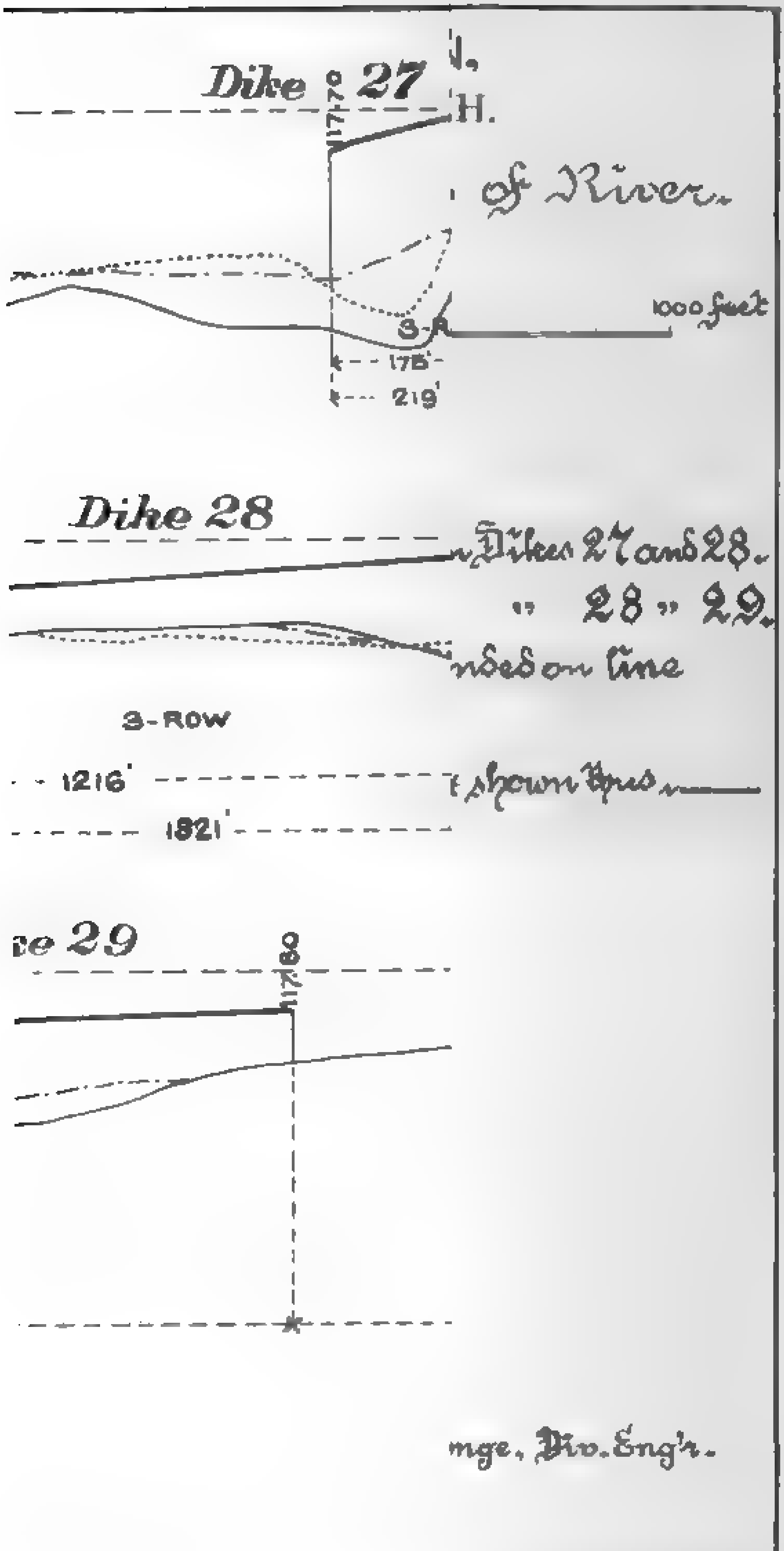
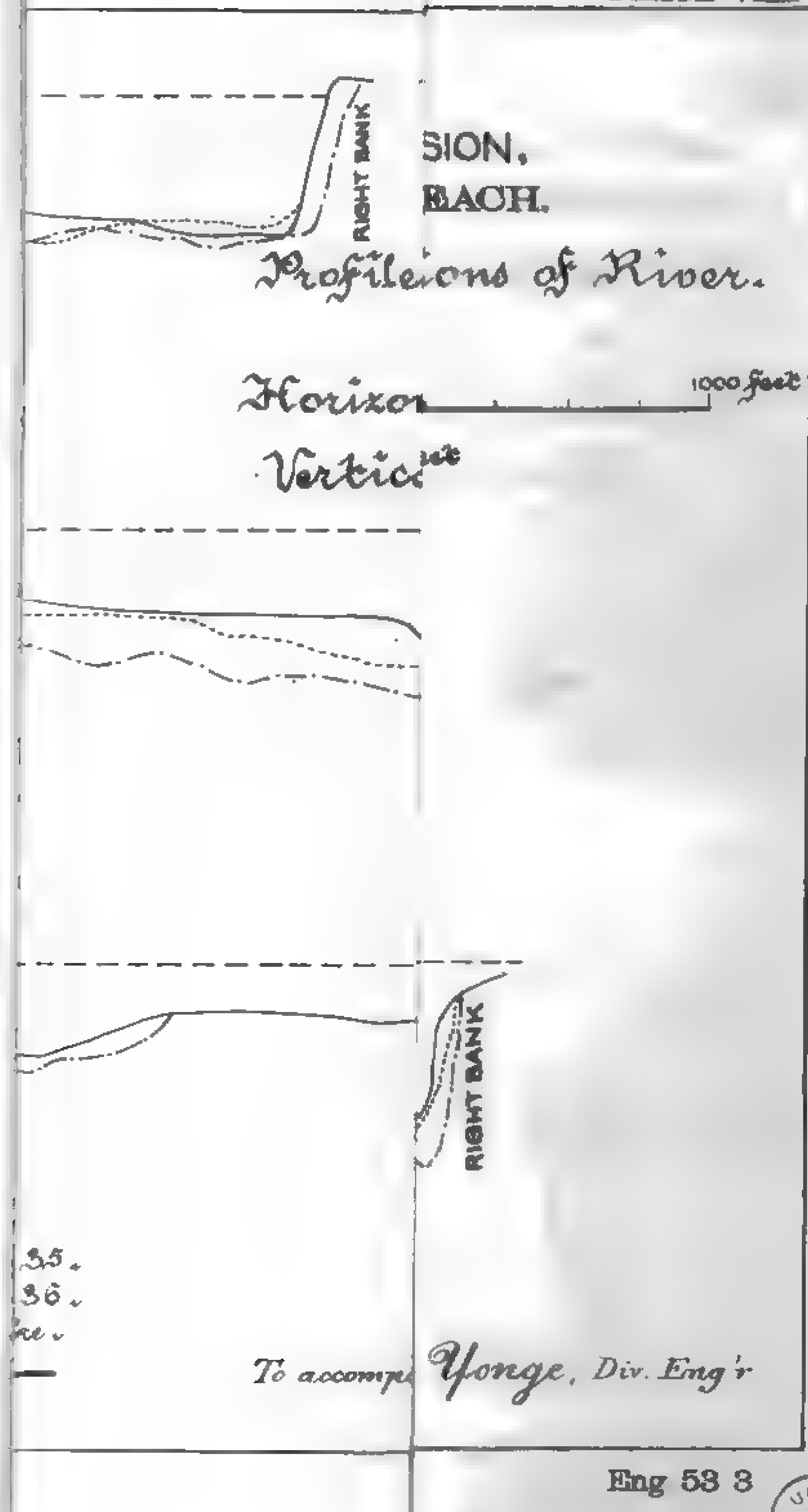

Dike 27
117.70
H.
of River.
1000 feet
3-R
175'
219'
Dike 28
Dikes 27 and 28.
" 28 " 29.
nded on line
3-ROW
1216'
shown thus
1821'
e 29
117.80
mge, Div. Eng'r.

PLATE VIII


SION,
EACH.
Profileions of River.
Horizo
1000 feet
Vertic
RIGHT BANK
RIGHT BANK
35.
36.
To accomp
Yonge, Div. Eng'r

Statement of expenditures on account of plant.

Application.	Labor and subsistence.	Material.	Total for each item.	Totals.
Plant construction:				
Ten 100-foot barges	$22,042.02	$11,190.85	$33,232.87	
Coal platform, coal chutes, and bath house at Bennets mill	361.67	210.64	572.31	
Set of storage tracks and switch track extension	1,853.19	1,569.83	3,423.02	
Twenty-horse capstans	413.89	37.45	451.34	
Miscellaneous	8,975.95	2,991.25	11,967.20	
Steam and water pipe fittings and plumbing fixtures, etc			688.48	
				$50,335.22
Repairs to plant:				
Lengthening steamer Doris	1,012.78	194.40	1,207.18	
Tower loads	894.66	73.05	967.71	
Repairs to hydraulic grader No. 5	674.82	65.83	740.65	
Repairs to launching ways and storage tracks	660.61	104.12	764.73	
Repairs to skiffs	237.11	61.97	299.08	
Changing grader No. 8 to steam hammer driver	317.07	166.38	483.45	
Repairs to pile sinker	3,361.05	1,037.01	4,398.06	
Miscellaneous	4,183.98	429.06	4,613.04	
Spring of 1894 repairs	758.29	56.53	814.82	
Tiller rope and chain			20.26	
Steam heater			135.78	
Engine frame, capstan gear, and other castings			113.46	
New chimneys and stovepipe			109.00	
Steam hose			120.50	
				14,856.72
Care of plant:				
Pulling out fleet, winter of 1893	3,493.61	235.21	3,728.82	
Launching fleet, spring of 1894	552.31	15.15	567.46	
General care of plant	11,363.65	651.09	12,014.74	
Raising and pulling out sunken grader No. 8	510.23	23.44	533.67	
Rope			794.47	
Coal oil, soap, matches, gasoline, and other supplies			421.40	
				18,060.56
New plant purchased:				
Stoves, ranges, brooms, brushes, mess utensils, lamps, crockery, clocks, office furniture, quarter-boat furniture, filter, and other utensils			1,484.86	
Oars, lanterns, oilers, wrenches, augers, platform scale, brush hooks, files, shovels, differential blocks, emery wheels, padlocks, etc			331.99	
Babcock fire-extinguisher			38.50	
				1,855.35
Administration			3,256.18	
Office and incidental expenses			4,637.10	
Steamboat service			8,885.22	
				16,778.50
Total				101,886.35

The value of plant and material on hand amounts to $9,307.40.

SURVEYS.

The periodical sounding of cross sections on the established ranges of the reach under improvement was kept up till field operations were suspended in the fall, about which time, on account of want of funds, the regular survey party was disbanded and only a few of the sections occasionally sounded.

The total number of sections sounded amounted to 588. Other work carried on by the survey party consisted of making a survey of the reach between the head of Stanley Island and Portland in September and October, making 19 discharge measurements and giving lines and elevations for dike construction.

All the field notes have been platted and areas of sections computed and tabulated.

The total cost of surveys, including mapping, tracing, etc., amounts to $5,645.89.

Very respectfully, your obedient servant,

SAM'L H. YONGE,
Division Engineer.

Lieut. Col. CHAS. R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

APPENDIX F.

ANNUAL REPORT OF S. WATERS FOX, DIVISION ENGINEER, GASCONADE DIVISION, 1894.

MISSOURI RIVER COMMISSION,
OFFICE OF DIVISION ENGINEER, OFFICE BOAT MARGARET,
Gasconade, Mo., June 30, 1894.

COLONEL: I have the honor to submit the following report of the operations under my charge on the Gasconade division of the Missouri River during the fiscal year ending June 30, 1894, viz:

Operations on this division consisted in the care, repair, and alteration of plant; the construction of new plant, revetment, and dikes; survey and other miscellaneous work incident thereto. The following illustrations accompany, viz:

A map (Pl. I) of the reach embraced in the project, from Little Tavern Creek to Gasconade River, showing progress of improvements and location of works proposed for its completion.

Six plates (II to VII) showing in superimposition cross sections of the river, on permanent range lines, taken before, during, and after dike construction.

Eight photographic views (Pls. VIII to XV) of dikes in various stages of construction.

Two photographic views (Pls. XVI and XVII) taken in the Gasconade boat yard, showing boats in process of construction, on the storage ways; and on the incline.

CARE, REPAIR, AND ALTERATION OF PLANT.

The principal item of expense incurred in the care of plant was that involved in the construction, begun during the month of May, 1893, of launching and storage ways in the yard at Gasconade, Mo. I beg leave to refer to my report for the fiscal year ending June 30, 1893, for a description and the design of the ways. Work was carried on with a small force until September and then pushed vigorously with a larger force until its completion, November 4, 1893. During the fiscal year, 2,421 piles were driven of which 1,601 were for the support of storage ways, 80 for shunting tracks, and 740 for inclined or launching ways. The aggregate length of way timbers placed on the piles was 20,444 feet. The total area afforded by the ways, including shunting tracks and needles, for the storage of hulls, is 238,312 square feet. The inclined ways present a frontage of 325 feet to the river and extend from the top of the bank at an elevation of 19.67 feet above S. L. W. to an elevation of 7.72 feet below S. L. W. The plane of the surface of the storage ways proper is 22.2 feet above S. L. W.

The pulling out of boats, and placing them in the respective positions assigned them on the ways, was begun November 5 and finished December 2. The total number of hulls pulled out was 105, having an aggregate displacement of 5,437.35 tons. Sixty-six skiffs were also taken out of the river and stored under the ways. The total number of hulls then in the yard was 110, as follows, viz: 1 towboat, *Alert;* 1 towboat, *Sabrina;* 2 stern-wheel tenders (in process of construction), 1 side-wheel tender, *New Thetis* (in process of construction), 9 quarter boats, including the office boat, 12 mattress boats, 7 pile-sinkers (machine boats), 6 cross boats for pile-sinkers (3 tower leads and 3 umbrellas), 4 hydraulic graders, 40 barges, 25 by 100 feet; 23 barges, 16 by 65 feet; 1 barge, 20 by 54 feet, and 3 small hulls of odd sizes.

The above constitutes the entire fleet on the division, except two barges, one 25 by 100 feet and one 20 by 54 feet. The former was in the custody, during the winter, of the U. S. snag boat, *C. R. Suter,* and is now lying at the bank here; the latter was wintered in the Gasconade River.

The power used in the above work was furnished by steam and horse capstans. Of the former there were four double-barrel capstans, two of which were operated by the engine off the *Phœnix,* and two by a pair of nigger engines taken from one of the old snag boats. They were mounted in pairs on two special portable frames, and at such an elevation as would give them a clear range over the major portion of the yard.

The boats having been thus disposed of, the yard was thoroughly overhauled and cleaned; the lines, blocks, tools, and machinery of all kinds were collected, sorted, cleaned, and stored. Board walks were built and ladders and gangways placed so as to make every part of the fleet and yard readily accessible. Shores, to take the weight of the overhang or rakes of hulls, were placed where it seemed advisable. In the early spring of the current year all of the hulls were thoroughly cleaned out and flooded, enough water being added from time to time to keep the floor timbers well covered. In some instances it was necessary to make in or batten the oakum, and even to add new oakum, but generally the seams closed soon after the application of water. All of the serviceable skiffs, 65 in number, were put into the river in March to avoid the expense and injury to them involved in calking that would otherwise have been necessary.

Just after the boats were pulled out in the winter, 852 linear feet of 4-inch water mains were laid in the yard for service, as indicated above, for supplying the quarters and for fire purposes. Seven plugs for the attachment of 2½-inch hose were located on the mains with reference to their efficiency in reaching the plant in case of fire. The duplex Worthington pump, 10 by 10 by 5¼ inches, of the outside packed plunger pattern, placed in the steam saw and planing mill for supplying the mains and the mill, proved too small. It broke down in a trial effort to furnish an effective 1-inch fire stream and was replaced by a Hooker pump, 14 by 18 by 8¼ inches, taken from pile-sinker No. 15. A pressure of from 50 to 80 pounds of steam was kept in the mill boiler continuously, except from the time involved in "cleaning out." A circular tank, having a capacity of 5,626.75 gallons, was constructed and erected just outside the engine room of the mill. In this way comparatively clear water was furnished for the boiler and through the mains to the quarters. As additional precautions against destructive fires, hand fire grenades were distributed about the yard, and in the houses and cabins; water barrels, containing a saturated brine, were placed, with buckets, on the roofs of the cabins; a 5-gallon Babcock fire-extinguisher was also put in the watchmen's quarters. The watchmen were drilled, to some extent by occasional false alarms, in getting a stream of water promptly into play from different plugs. Day and night during the winter months, and in the nights subsequently, two watchmen patrolled the yard, and one was stationed at the top of the tower leads, which, from their central position, commanded a view of the entire yard. It was a part of the duty of the latter to tap a bell at intervals of five minutes. There was a night watchman also on the office boat. The labor and expense involved in these measures seemed to be warranted by the value of the property cared for, approximately $387,000, and the character of "the risk."

In addition to such current repairs as were necessitated from time to time by breakages, or ordinary wear and tear incident to service, the following work was done, viz: A new pilot house was put on the steamer *Sabrina;* three umbrella cross boats were repaired, provided with new fixed pile-leads, and outfitted for service; a pair of old double pile-leads arranged for driving piles 13 feet apart, were repaired and changed for 10 feet spacing, set on a barge 20 by 54 feet and outfitted for service. The cabins on barges Nos. 65 and 90, formerly used as quarters for construction parties, were taken from the hulls and placed in the yard for use as warehouses.

The following alterations were made in the rooms on the lower deck of the office boat, viz: Two small rooms, for storage of trunks and records, respectively, were cut off the forward end of the subsistence store room; the after bulkheads were moved forward, to afford more space in the laundry and boiler rooms, and a small room for the storage of canned goods and medicinal supplies. This left a room 19½ by 24½ feet for the storage of heavy subsistence goods. The small store room on the port side, just aft the gangway, was converted into two rooms for use in developing and printing photographs and blue prints. A dining-room 9 by 16 feet, for use of the watchmen and the boat's crew, was partitioned off from the after store room and the remaining space utilized as a drafting room. A shed 4½ by 17 feet, for the storage of bar iron, and opening into the blacksmith shop, was erected. A room was partitioned off at the west end of the storage sheds and provided with shelving for storing stock pipe fittings. By your instructions, the office boat and quarter boat No. 84 were calked and launched June 13 and 21 instant, respectively. The cost in item of the various operations under the above heading is shown in the appendix, Exhibit A.

NEW PLANT.

The authorized new plant, the construction of which had not been begun, or was unfinished at the close of the previous fiscal year, was as follows, viz: 5 barges, 25 by 100 feet; 5 mattress boats, 26 by 70 feet; the office boat; 2 stern-wheel steam tenders, 18 by 91½ feet; the side-wheel steam tender *New Thetis,* 15 by 74 feet; 3 six-lead towers for jet pile sinking; 2 pairs of leads for Cram steam hammers; and 9 one-pair-oared skiffs.

In accordance with your instructions, no work was done on the proposed barges. The 5 mattress boats were finished, and together with the 4 made during the previous fiscal year, were outfitted for service, with capstans, reels, and fair leaders. One of them, the materials for which did not arrive until late in the season, was not launched. The others were launched July 29, 31, and August 3. The office boat had been finished during the previous year, except some work by the painters and steam fitters. The materials for the latter did not arrive until November 4. The boat was outfitted and put in service in the latter part of August. The entire office force was installed on her soon after, and the Hermann office closed November 30, 1893.

Work on the *New Thetis,* begun August 23, 1893, and suspended by your order dated September 1, was resumed September 16 in accordance with instructions contained in your letter dated September 13. The construction of the stern-wheel tenders was begun September 23, as authorized in the same letter. On December

15 work on the three steamers, having progressed as far as was thought desirable in advance of the arrival of the machinery for them, was suspended. The boilers, furnace beds, stacks and breechings, etc., for all, and the engines for the stern-wheel boats, arrived March 5, 1894. They were promptly unloaded from the cars to their respective hulls and construction resumed. On April 16, by your direction, the force was reduced to that authorized for the period of inactivity, and subsequent work on the steamers confined mainly to protecting them against weather. The present status of the stern-wheel tenders is about as follows, viz: The carpenter work on the hulls and cabins is finished; all of the woodwork has been given a priming coat, some of it two coats, and the roofs three coats of paint; the rudders and pilot wheels have been built and the materials for the stern wheels gotten out; the engines and wheel shafts are in place; three of the pitmans have been made; the boilers are swung ready to lower into place.

Tables giving elements of weight and showing results of computation in detail for displacement, capacity, centers of gravity and buoyancy, and accompanied by diagrams presenting the data graphically, were prepared and submitted with my letter dated June 7, 1894. The total weight of each tender, equipped for service and with 5 tons of coal aboard, is given as 73.218 tons; the draft under the same conditions, 22.76 inches. Drawings were prepared and submitted, under date of June 19, showing an elevation and a vertical section of the steamers as they were constructed.

The hull of the *New Thetis* has been finished; the roof, skylight, and wheelhouses built; the roof and skylight have been canvassed, and, together with all the woodwork, has been painted. The boiler is aboard, but not in place. Bills of piping, steam fittings, and other essential fixtures necessary for the three boats, were prepared and submitted under dates of March 19 and 21.

The three new tower-leads were finished, placed on the new cross-boat hulls, and outfitted with toggle irons, fair leaders, blocks, steam and water connections, steam hoists, etc., necessary for service in jet pile work.

The two Cram hammer leads were completed and placed in position for service on hydraulic graders Nos. 1 and 6. These pieces were chained and braced to insure an easy distribution of the stresses imposed by their new loads. The large grading pumps were removed.

The cabins and machinery were removed from the old pile-sinker hulls Nos 2, 12, and 15, and placed on the new hulls.

The last of the nine one-pair-oared skiffs was finished September 19.

REVETMENT CONSTRUCTION.

Operations under this heading were confined to the completion, between July 1 and 5, of the upper bank work on the boat-yard revetment, and the construction and placing, in the fall, of 14,910 square feet of mattress for the protection of the piles supporting the submerged launching ways. Three hundred and eighty-two cubic yards of rock were expended on the former work and 175 cubic yards on the latter, making the total quantity of rock ballast expended on the 3,210 linear feet of revetment 8,744 cubic yards.

The cost of these works is shown in item in the Appendix, Exhibit B.

DIKE CONSTRUCTION.

The first dike party was put in the field August 16, 1894; a second party began work eight days later. Owing to the nonarrival of some of the articles of equipment neither party was properly prepared for service. This fact, the inexperience of the crews, and some local conditions of flow, which necessitated frequent shifting about of the working plant from one dike to another, operated to make progress slow. Probably not to exceed thirty days' work with two parties under fairly good conditions had been done when instructions from you were received, under date of October 27, to suspend fieldwork as soon after November 1 as could possibly be done without too great danger to incomplete work. Subsequent operations until final suspension on December 15, 1893, were confined to the completion of those dikes already begun, which were thought to be of greatest importance, and consisted mainly in extending them to a connection with the main bank. Dike No. 14 was abandoned, as the work necessary to put it in proper shape would have cost more than was warranted by the instructions.

The following is a statement of the class and extent of pile dike work done:

Dike No.	Length constructed.	Class and length. 2-row.	3-row.	4-row.	Trail.	Number of piles. In dike.	Anchor.	Average penetration.	Remarks.
I	395	....	20	220	100	114	9	*15.6	Finished.
II	1,445	....	960	350	90	445	19	23.9	Do.
III	475	....	330	....	100	119	7	23.3	Do.
IV	1,065	....	960	....	70	302	26	24.4	Do.
V	390	....	250	....	100	95	5	21.5	Do.
VI	280	....	250	....	....	76	4	22.6	730 feet to complete.
VII	*470	....	....	370	100	170	5	*15.6	Finished.
VIII	1,350	480	590	180	100	365	24	20.3	Do.
IX	650	....	....	500	100	220	11	18.2	Do.
X	1,050	130	720	....	100	272	17	22.3	Do.†
XI	880	....	720	....	100	236	20	17.0	Do.
XII	1,200	270	830	....	100	323	17	22.7	Do.
XIII	265	....	180	....	50	64	4	17.7	1,060 feet to complete.
XIV	000	....	....	....	....	148	18	23.4	2,250 feet to complete.
XV	260	....	200	....	....	60	5	21.5	1,540 feet to complete.
Total	10,175	880	6,010	1,620	1,110	3,009	191	21.2	

* Penetration limited by rock bottom. † One hundred feet of single row work done on this dike.

The cost of this work is shown in the Appendix, Exhibit C.

In general design the dikes correspond closely with those described in previous reports; the only differences that seem noteworthy being the construction of a 2-row trailing dike, extending from the outer end of the main dike 100 feet downstream, on or near the projected shore line; the lowering of the outer ends of the dikes to a uniform elevation where possible of 1½ feet above S. L. W., cutting all piles in a bent to a common elevation, and the use of double instead of single direct braces. The piles used in the dikes were, with a few exceptions, white oak; the wales and braces were long-leaf yellow pine—heart stuff.

The use of steam hammers, of which there were four, namely, three "B" Cramm and one No. 2 Vulcan, although too limited perhaps for final conclusions, clearly indicated their superiority in range of usefulness, as well as efficiency, to the jet sinking apparatus used almost exclusively heretofore. The bed formation is such in places that the use of a jet apparatus in securing proper penetration of the piles is tedious and costly, if not impracticable. The action of the steam hammer is positive, insuring the desired penetration, except, of course, in rock bottoms, and thus effecting incidentally a very considerable economy in the length of piles used. Its manipulation is simpler than that of the jet apparatus, leaving less room for errors of judgment on the part of the operators. In a number of cases during the season's work piles were readily driven to desired penetrations after every possible resource with a jet had been exhausted without success.

The rock, brush, and poles used on the dikes were procured by hired labor. The former was derived from three points, viz, the Gasconade quarry, which was opened during the previous fiscal year; Keith's Rock, and near Little Tavern Creek.

Keith's Rock is a large detached fragment of sandstone, lying just inside the project line, on the right bank of the river, about 1 mile above the boat yard. It was purchased at 1 cent per cubic yard, measured on barges, with a view to its removal as an obstruction to flow and navigation, and at the same time the utilization of the rock ballast produced. Two thousand four hundred and seventy-five cubic yards were thus acquired, degrading the general level of the rock to about 6 feet above S. L. W.

Six hundred and fifty cubic yards of ballast were secured from the bank just below the mouth of Little Tavern Creek, where a number of large fragments of rock, detached by blasting during the construction of the M., K. & E. Railroad, lie within the waterway. The privilege of removing and using this rock was accorded by the above-mentioned railroad company without cost to the United States.

A brush party was put in the field August 8 and kept in service continuously, except for an interval of sixteen days in October, until November 4. Four thousand and sixty cords of brush were procured. The longest tow of this material was from the patch in Charette bend to the head of the work, a distance by river of 41 miles.

The location of the dikes as built, and the result of their action on the channel thus far, i. e., up to the date of the last survey in April, 1894, may be seen on the accompanying map. The progressive changes of section, during the period from March, 1893, to April, 1894, may be seen on the accompanying plates (II to VII), which give superimpositions of profiles of bottom on permanent range lines, taken before, during, and subsequent to the construction of the dikes. On that portion of the reach, clearly within range of the influence of the dikes, the improvement is marked and as desired. That the results are not more marked is undoubtedly due to the fact that up to the time of the last survey no flood of consequence had occurred, the highest stage reached being 9.47 feet above S. L. W. No damage was done to the dikes during the winter and none since.

TOWBOAT SERVICE.

The U. S. towboat *Alert* was in service from July 1 to September 30, 1893. From July 1 to 27 she made three round trips between Gasconade and East Bottoms, near Kansas City, Mo., for floating plant, delivering twenty-one hulls at the former place. From August 18 to September 11 she made three trips between Gasconade and Bushberg, Mo., bringing nineteen hulls from the latter point. The balance of the time she was engaged on the Gasconade division in towing construction materials and handling plant.

The U. S. towboat *Wm. Stone* was in service until July 16, during which time she delivered at Gasconade one tow of six hulls from East Bottoms, and two tows aggregating sixteen hulls from Bushberg. She cleared on July 16 from Gasconade with instructions to report at Ewings Landing to Division Engineer Samuel H. Yonge.

The U. S. towboat *Sabrina* was in service continuously handling construction materials and plant until November 4, on which date she was laid up at the ways.

The chartered steamers *Gasconade* and *Millboy* were in service as follows, viz: The former until July 15 in towing floating plant from East Bottoms to Gasconade; during which time she delivered seven hulls in two tows. From August 11 to November 23 she was engaged in handling construction materials and plant on this division.

The *Millboy* was engaged in occasional service of the latter kind from September 9 to October 6, and continuously from October 11 to November 28, 1893.

SURVEY WORK.

During active construction operations a small survey party was kept almost continuously in the field, sounding on the permanent ranges and dike lines; giving grade and line to dike parties; on slope observations; partial shore-line work; the establishment and verification, from time to time, of temporary local gauges; and in miscellaneous work incident thereto. A complete hydrographic survey of the reach from Little Tavern Creek to Gasconade River was made April 6 to 27, 1894. A map of this survey to a scale of 1 inch equals 1,000 feet was prepared, and a tracing of it submitted, under date of May 26, to the secretary of the Commission with the request that it be reduced to a scale of 1 inch equals 2,000 feet. A tracing of the reduced map accompanies the report.

The cost of all survey work during the year was as follows, viz:

Labor	$1,490.82
Subsistence	127.57
Material	19.95
Total	1,638.34

Under date of February 26, 1894, a revised project, with estimates of cost for the completion of the improvement of the reach from Little Tavern Creek to Gasconade River, was submitted. The project involved no change in the alignment of the proposed rectified river as approved, but recommended some changes in location of work, and some additional works that were deemed advisable or were necessitated by new conditions of flow (see accompanying map), viz:

An extra dike XV, A is proposed; dikes XVII, XIX, and XXI are shown in slightly changed positions; XXII is an extra dike; dike XXVIII is located 1,000 feet lower down than originally proposed; the revetment in Straub's bend is extended 1,150 feet further upstream than in the approved project; a new system of dikes, XXX, XXXII, and XXXIV, is proposed. The following is a condensed statement of the estimated cost of the completion of the improvement of the reach in accordance with the project revised as above, viz:

Statement.

Estimated cost of proposed dike work		$241,020.00
Estimated cost of proposed revetment work		67,100.00
Care and repair of plant, calking, launching and pulling out same		20,500.00
New plant, tools, lines, etc		10,000.00
Add for items of administration, survey, traveling expenses, sundry miscellaneous		20,000.00
Total estimated cost		358,620.00
Credit by cost value of materials on hand and paid for:		
Dike materials	$27,274.77	
Dike or revetment materials	5,833.83	
		33,108.60
		325,511.40

This amount could be profitably expended during the fiscal year ending June 30, 1895, provided work can be begun not later than August 1, 1894.

Very respectfully, your obedient servant,

S. WATERS FOX,
Division Engineer.

Lieut. Col. CHARLES R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

List of exhibits forming appendix accompanying the foregoing report.

Exhibit A.—Cost in item of care, repair, and alteration of plant.
Exhibit B.—Cost in item completing revetment at Gasconade boat yard.
Exhibit C.—Cost in item of pile dike construction.

EXHIBIT A.—*Care, repair, and alteration of plant, 1893.*

	Labor.	Subsistence.	Material.	Supplies.	Total cost.
Care of plant:					
Watching	$4,588.88	$1,462.42	$7.11	$70.08	$6,128.49
Construction of boatways	10,159.81	2,524.10	7,052.33	49.50	*19,785.74
Anchorage, planting "dead men"	246.00	106.33	89.25		441.58
Pulling out boats	2,987.65	952.74		285.21	4,225.60
Storing and caring for plant	8,339.88	2,656.09	5.86		11,001.83
Fire protection	758.46	219.22	260.56	255.15	1,493.39
Repair and alteration of plant:					
Old umbrella boats	563.28	120.54	93.18		777.00
Sabrina pilot house	48.00	10.27	22.73		81.00
Changing double pile leads	33.00	7.06	1.21		41.27
Removing and repairing Belmont cabins	409.47	87.63	3.24	2.30	502.64
Office boat Margaret, cabin alterations	54.70		13.94		68.64
Repairing and launching cabin boats Margaret and De Russy	132.32		19.24	2.50	154.06
Miscellaneous and current repairs	3,653.60	781.87	304.27	2.08	4,741.82
Grand total	31,075.05	8,928.27	7,872.92	666.82	49,443.06

* NOTE.—$5,244.79 of this amount expended during the fiscal year ending June 30, 1893.

EXHIBIT B.—*Cost of finishing Gasconade boat-yard revetment, 1893.*

Class and extent of work done.	Cost. In item.	Cost. Total.
Ballasting upper bank (200 linear feet):		
Material, 382 cubic yards of rock at 75 cents per cubic yard on barge at point of expenditure	$286.50	
Labor, placing same on bank	156.20	
		$442.70
Constructing and ballasting mattress (415 linear feet, or 14,910 square feet):		
Construction:		
Labor	242.22	
Materials:		
140 cords brush on barge at point of expenditure	323.54	
684.08 pounds three-eighths-inch strand (galvanized steel)	25.93	
1,235 pounds second-hand car cable	18.52	
		610.21
Ballasting:		
Labor	18.31	
Materials, 175 cubic yards rock, at $1.0509 per cubic yard on barge at point of expenditure	183.90	
		202.21
Grand total		1,255.12

EXHIBIT C.—*Cost in items of pile dike construction, 1893.*

Kind of materials.	Quantity.	Cost on cars or at landings.	Cost of unloading cars, handling and barging.	Cost of towing.	Total cost at points of expenditure.	Labor, subsistence, and supplies.	Total cost in dike.
Piles:							
White oak.....No..	2,721	$13,909.52					
Water oak....do...	134	507.69					
Cottonwood...do...	154	315.20					
Water oak*...do ..	37	179.19					
Total†	3,046	14,911.60	$2,033.42	$1,107.51	$18,052.53	$9,858.33	$27,910.86
Wales and braces, feet, B. M	387,755	6,823.52					
Bolts, screw.......lbs..	30,533	454.86					
Bolts, drift. ......do...	5,936	111.57					
Washers..........do...	7,400	169.69					
Total		7,559.55	1,417.40	412.88	9,389.83	‡4,830.80	14,220.63
Brush...........cords..	3,810	5,108.50		3,620.84	8,729.34	5,032.53	13,761.87
Rock ....cu. yds..	6,821	6,321.07		1,329.97	7,651.04	1,872.38	9,523.42
Anchor:							
Piles ....No..	191	574.56		96.43		618.15	
Three-eighths-inch strand......feet..	149,540	1,480.45				678.68	
Cable ....do...	11,599	173.98					
Total		2,228.99		96.43	2,325.42	1,296.83	3,622.25
Curtain:							
Poles ....cords..	336	762.90		403.14		1,617.92	
Spikes ....lbs..	3,000	67.62					
Total		830.52		403.14	1,233.66	1,617.92	2,851.58
Grading bank							211.82
Grand total							72,111.43

* Broken in driving. † Dike piles. ‡ Includes $48 labor lashing on wales and braces.

PLATE I.

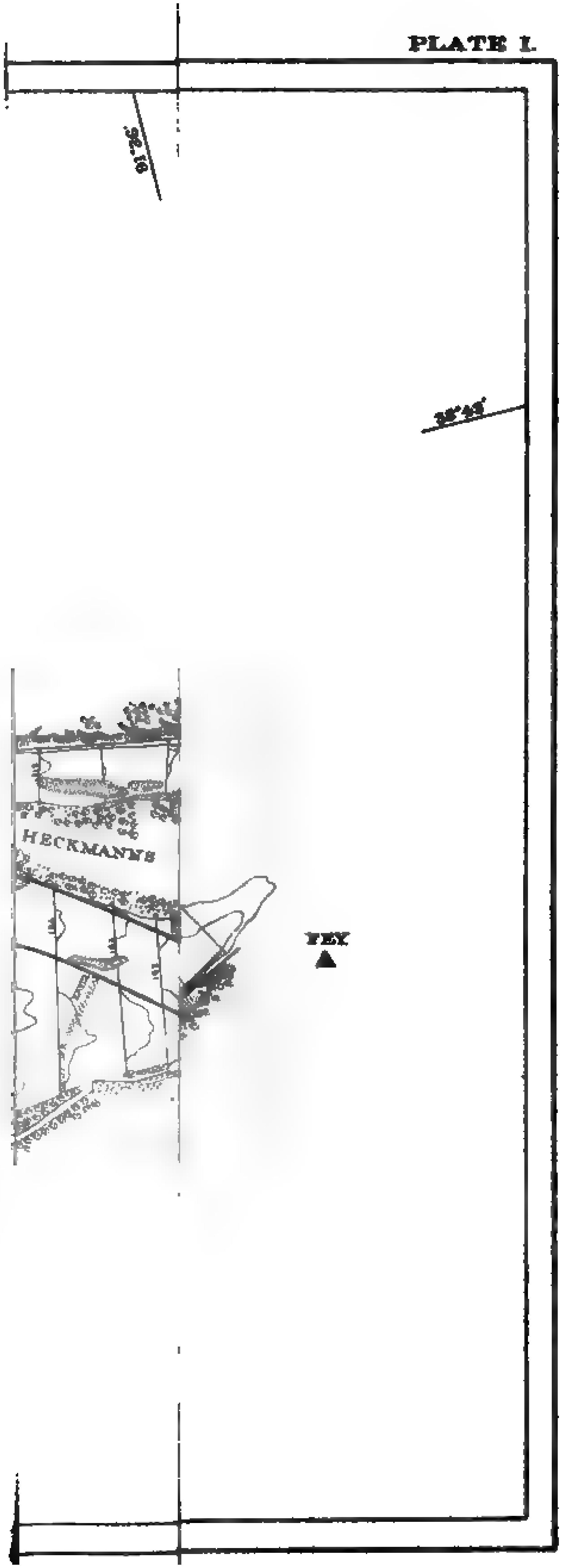


PLATE II.

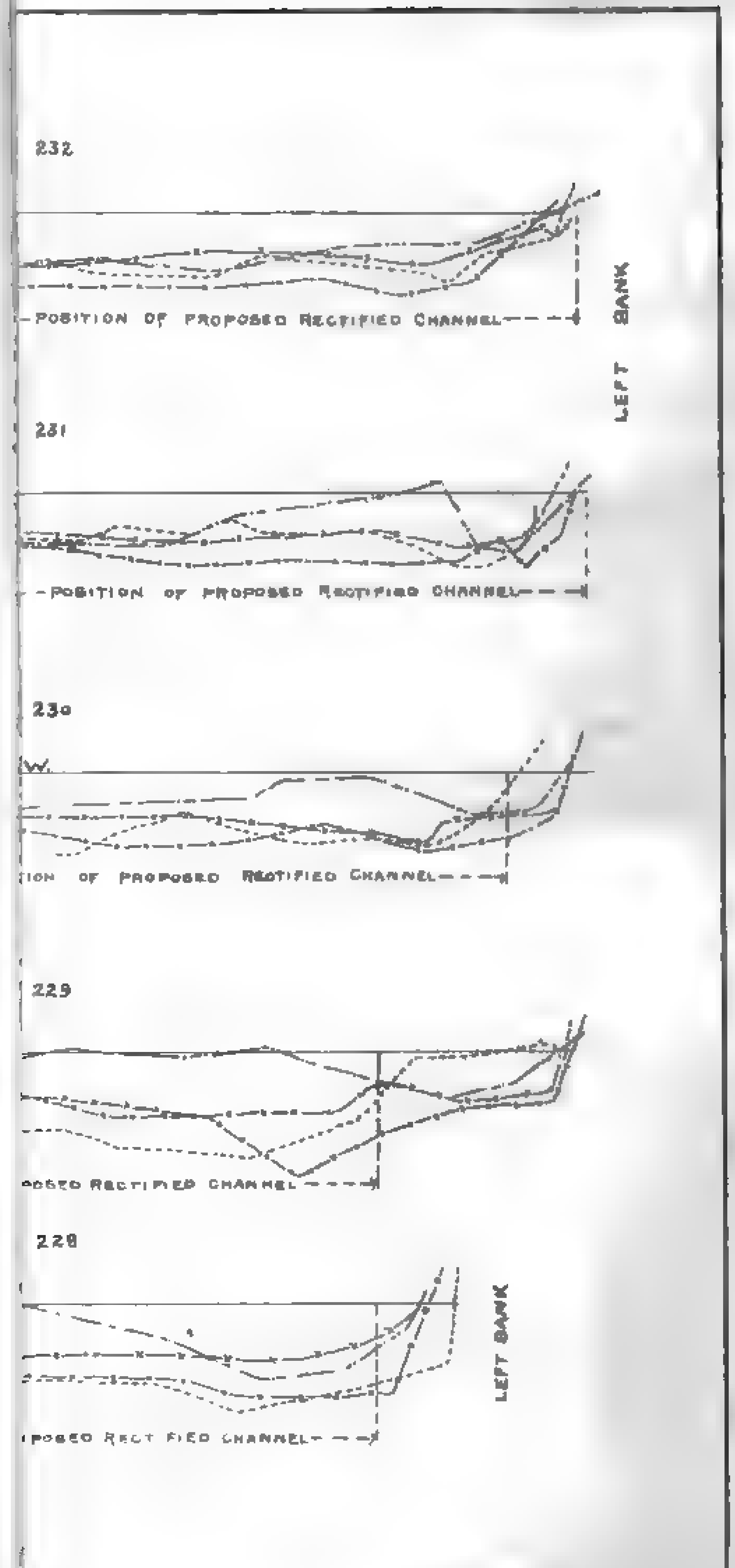

232
POSITION OF PROPOSED RECTIFIED CHANNEL
LEFT BANK
231
POSITION OF PROPOSED RECTIFIED CHANNEL
230
W.
ION OF PROPOSED RECTIFIED CHANNEL
229
POSED RECTIFIED CHANNEL
228
POSED RECTIFIED CHANNEL
LEFT BANK

PLATE III.

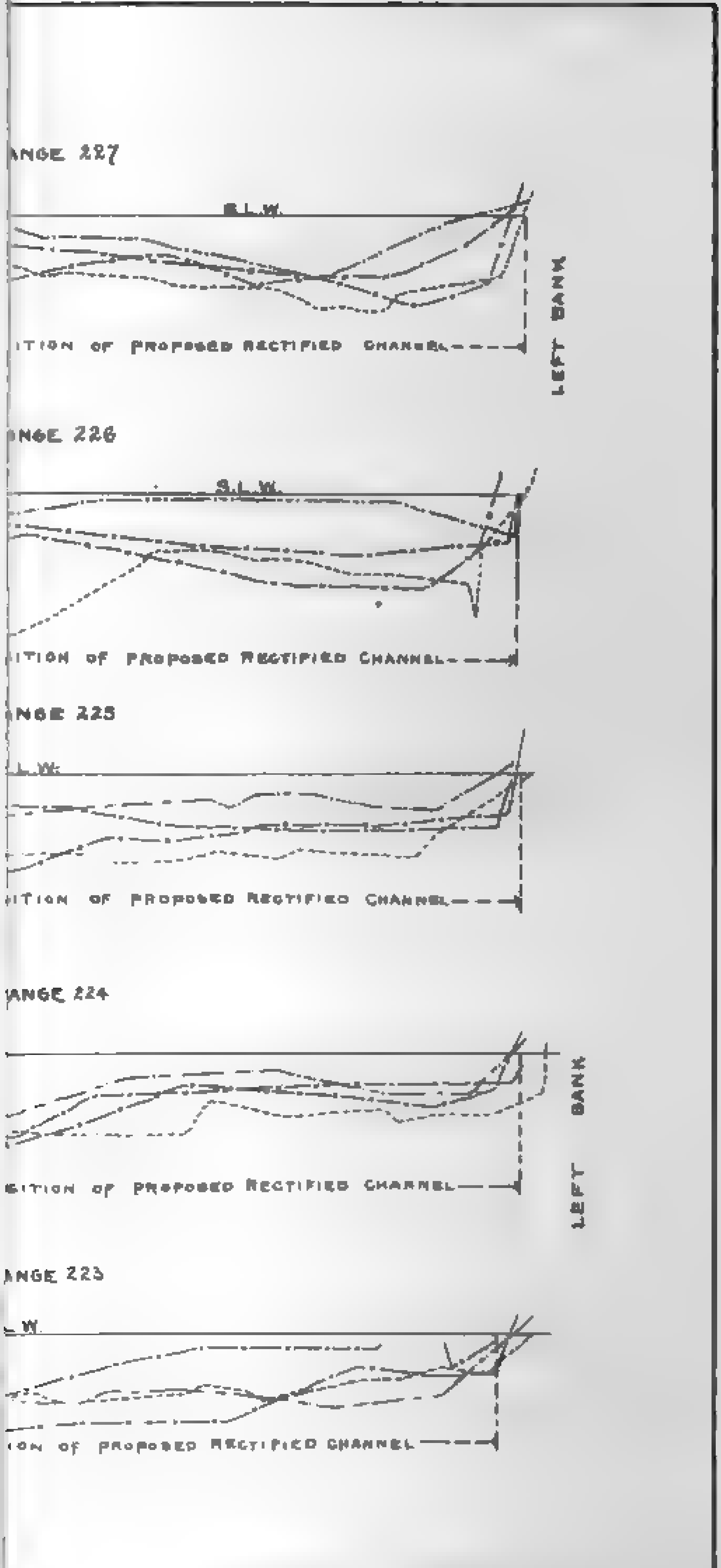

ANGE 227
S.L.W.
ITION OF PROPOSED RECTIFIED CHANNEL
LEFT BANK
NGE 226
S.L.W.
ITION OF PROPOSED RECTIFIED CHANNEL
ANGE 225
L.W.
ITION OF PROPOSED RECTIFIED CHANNEL
ANGE 224
SITION OF PROPOSED RECTIFIED CHANNEL
LEFT BANK
ANGE 223
L.W.
ION OF PROPOSED RECTIFIED CHANNEL

PLATE IV.

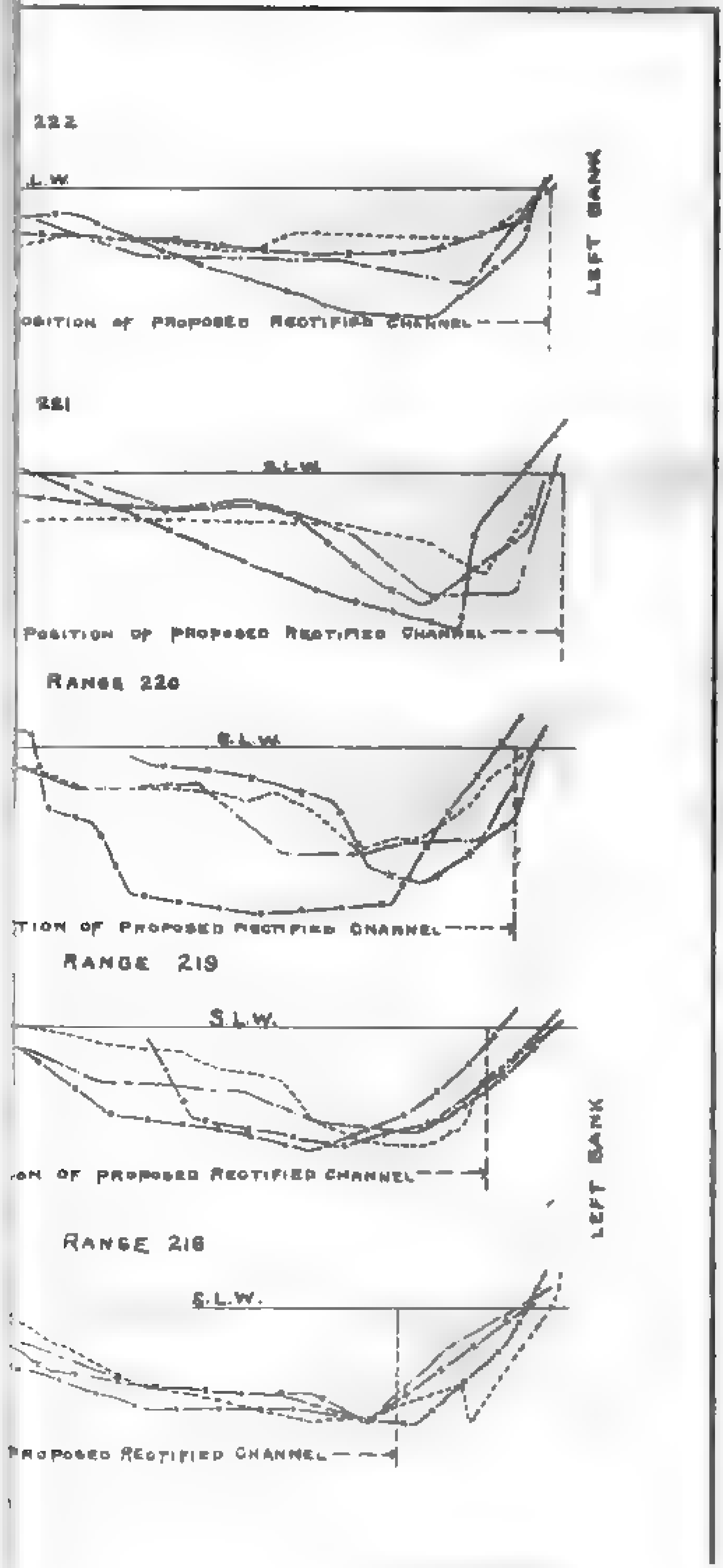

222
S.L.W.
OSITION OF PROPOSED RECTIFIED CHANNEL
LEFT BANK
221
S.L.W.
POSITION OF PROPOSED RECTIFIED CHANNEL
RANGE 220
S.L.W.
TION OF PROPOSED RECTIFIED CHANNEL
RANGE 219
S.L.W.
ON OF PROPOSED RECTIFIED CHANNEL
LEFT BANK
RANGE 218
S.L.W.
PROPOSED RECTIFIED CHANNEL

PLATE V.

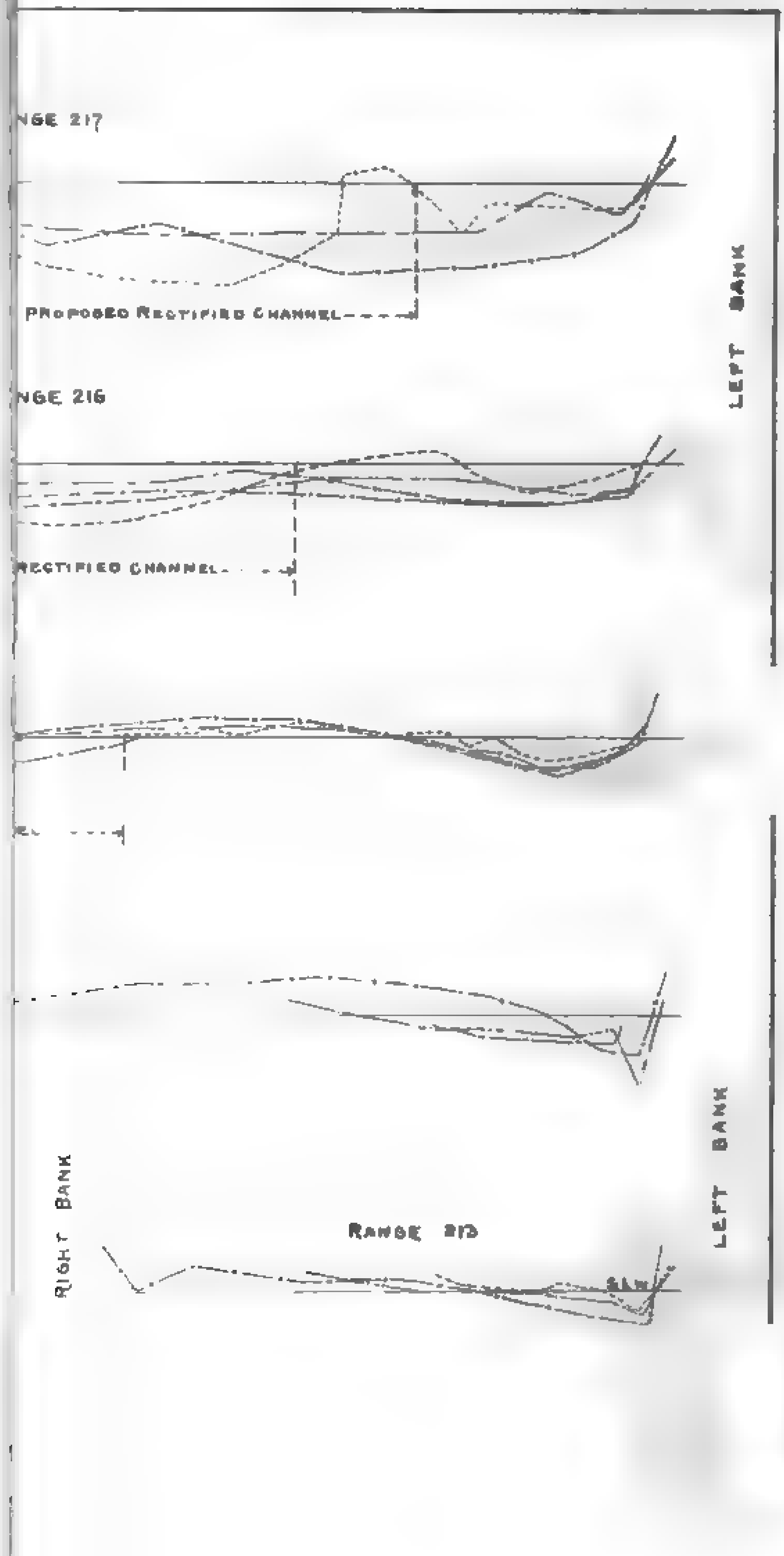

NGE 217
PROPOSED RECTIFIED CHANNEL
LEFT BANK
NGE 216
RECTIFIED CHANNEL
RIGHT BANK
RANGE 213
LEFT BANK

PLATE VI.

SSOURI RIVER COMMISSION.

GASCONADE DIVISION

CROSS SECTIONS OF RIVER

SCALES:

HORIZONTAL

100 0 1 2 3 4 500 Ft

VERTICAL

10 0 1 2 3 4 50 Ft

Reference

MARCH 893

JUNE 1893

NOV'R 1893

APRIL 1894

nual report for 1894, of J. Walters Fox, Div. Engineer

EXHIBIT B.—*Cost of finishing Gasconade boat-yard revetment, 1893.*

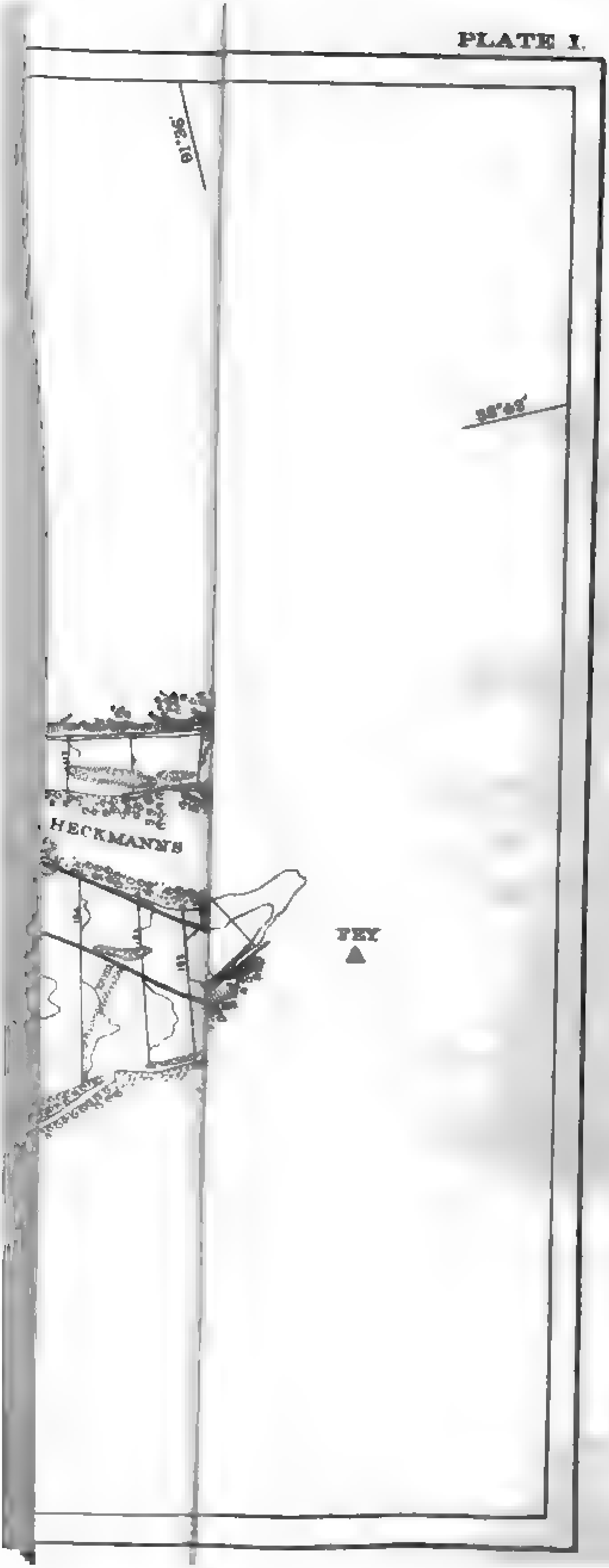
Class and extent of work done.	Cost. In item.	Cost. Total.
Ballasting upper bank (200 linear feet):		
Material, 382 cubic yards of rock at 75 cents per cubic yard on barge at point of expenditure	$286.50	
Labor, placing same on bank	155.20	$44[illegible]
Constructing and ballasting mattress (415 linear feet, or 14,910 square feet):		
Construction:		
Labor	242.22	
Materials:		
140 cords brush on barge at point of expenditure	323.54	
684.08 pounds three-eighths-inch strand (galvanized steel)	25.93	
1,235 pounds second-hand car cable	18.52	
		61[illegible]
Ballasting:		
Labor	18.31	
Materials, 175 cubic yards rock, at $1.0509 per cubic yard on barge at point of expenditure	183.90	
		20[illegible]
Grand total		1,2[illegible]

EXHIBIT C.—*Cost in items of pile dike construction, 1893.*

Kind of materials.	Quantity.	Cost on cars or at landings.	Cost of unloading cars, handling and barging.	Cost of towing.	Total cost at points of expenditure.	Labor, subsistence, and supplies.	Total [illegible] in di[illegible]
Piles:							
White oak.....No..	2,721	$13,909.52					
Water oak....do...	134	507.69					
Cottonwood...do...	154	315.20					
Water oak*...do...	37	179.19					
Total†	3,046	14,911.60	$2,033.42	$1,107.51	$18,052.53	$9,858.33	$27,91[illegible]
Wales and braces, feet, B. M	387,755	6,823.52					
Bolts, screw.......lbs..	30,533	454.86					
Bolts, drift.......do...	5,936	111.57					
Washers..........do...	7,400	169.60					
Total		7,559.55	1,417.40	412.88	9,389.83	‡4,839.80	14,[illegible]
Brush...........cords..	3,810	5,108.50		3,620.84	8,729.34	5,032.53	13,7[illegible]
Rock ....cu. yds..	6,821	6,321.07		1,329.97	7,651.04	1,872.38	9,[illegible]
Anchor:							
Piles ....No..	191	574.56		96.43		618.15	
Three-eighths-inch strand......feet..	149,540	1,480.45					
Cable ....do...	11,599	173.98				678.68	
Total		2,228.99		96.43	2,325.42	1,296.83	3,[illegible]
Curtain:							
Poles ....cords..	336	762.90		403.14		1,617.92	
Spikes ....lbs..	3,000	67.62					
Total		830.52		403.14	1,233.66	1,617.92	2,[illegible]
Grading bank							[illegible]
Grand total							72,[illegible]

* Broken in driving. † Dike piles. ‡ Includes $48 labor lashing on wales and braces.

PLATE I.



APPENDIX G.

ESTABLISHMENT OF HARBOR LINES IN MISSOURI RIVER AT KANSAS CITY, KANSAS, AND KANSAS CITY, MISSOURI.

STATE OF KANSAS,
EXECUTIVE DEPARTMENT, GOVERNOR'S OFFICE,
Topeka, September 24, 1892.

SIR: I have the honor to inclose herewith the minutes of a joint conference of the executive committees of the State boards of health of Kansas and Missouri, held in Kansas City, Mo., on the 10th instant, to discuss the cholera situation; also, resolutions adopted by said executive committees.

I desire most respectfully to call your attention to the resolutions, and urge that the request therein presented may receive speedy and favorable consideration at your hands, and trust that you will direct the Missouri River Commission, of which Col. C. R. Suter is president, to establish the true river front or harbor line at Kansas City between the States of Kansas and Missouri.

Respectfully,

[Unsigned.]

Hon. STEPHEN B. ELKINS,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 30, 1892.

Respectfully referred to Lieut. Col. Chas. R. Suter, Corps of Engineers, for early report.

To be returned.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Third indorsement.]

MISSOURI RIVER COMMISSION,
St. Louis, Mo., October 12, 1892.

Respectfully returned to the Chief of Engineers, U. S. Army, with report of this date.

CHAS. R. SUTER,
Lieut. Col. of Engineers,
President Missouri River Commission.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 15, 1892.

Respectfully returned to the Secretary of War with recommendation that the Missouri River Commission be directed to take into consideration and report its recommendations upon the subject of harbor lines at Kansas City, Kans., and Kansas City, Mo.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Fifth indorsement.]

WAR DEPARTMENT, *October 17, 1892.*

Respectfully referred to the Acting Judge Advocate-General. What authority has the Secretary of War to direct the Missouri River Commission to consider and report upon the subject of harbor lines at Kansas City, Kans., and Kansas City, Mo.?

By order of the Acting Secretary of War:

JOHN TWEEDALE,
Chief Clerk.

[Sixth indorsement.]

WAR DEPARTMENT,
JUDGE-ADVOCATE-GENERAL'S OFFICE,
Washington, D. C., October 24, 1892.

Respectfully returned to the Secretary of War.

This is a request made by the State boards of health of Kansas and Missouri, through the governors of those States, that the Secretary of War direct the Missouri River Commission to locate and establish harbor lines in the harbor at Kansas City, Mo., and Kansas City, Kans.

It seems from a report of Col. Suter herewith that there is apparently a necessity for the establishment of lines in that harbor for the "preservation and protection of the harbor," but the question asked in the indorsement referring the matter to this office is, "What authority has the Secretary of War to direct the Missouri River Commission to consider and report upon the subject of harbor lines at Kansas City, Kans, and Kansas City, Mo.?"

I do not think he has such an authority in the sense that the Commission would be under obligation to obey such a direction given by him. That Commission is composed partly of civilians, and its duties under the statute relate exclusively to something other than establishing harbor lines. It is, therefore. not subject as a body to the orders or directions of the Secretary of War in the matter of establishing harbor lines, nor are its civilian members subject individually to such orders or directions; yet the law authorizing the establishment of harbor lines is such that the Secretary of War might act through the Commission in carrying it into effect, provided the Commission will act in the matter. That law is, that "when it is made manifest to the Secretary of War that the establishment of harbor lines is essential to the preservation and protection of harbors, he may, and is hereby authorized to, cause such lines to be established," etc.

He is not required to act through any particular agent or agency.

Still, the engineer officers of the Army are subject to the orders of the Secretary of War in this matter, and are competent to do this work, and I therefore recommend that one or more of them be designated therefor.

G. NORMAN LIEBER,
Acting Judge-Advocate-General.

[Seventh indorsement.]

WAR DEPARTMENT, *October 26, 1892.*

Respectfully returned to the Chief of Engineers.

If, in the opinion of the Chief of Engineers, the establishment of harbor lines is essential to the preservation and protection of the harbor at Kansas City, Kans., and Kansas City, Mo., he will appoint a board of engineer officers to examine and report upon the same, taking

all the necessary steps to establish a bulkhead line and a pier-head line at the points named. There is no objection to his detailing the three officers on the Missouri River Commission for that board, nor is there any objection known to his or their asking the other members of the Missouri River Commission to act with them, but it is not thought proper to direct the Missouri River Commission, as such, to establish harbor lines.

This case is considered one of unusual importance, as the establishment of harbor lines may affect the question of the boundary line between the two cities named and between the States of Kansas and Missouri. Full and complete surveys should be made, and the whole location should be thoroughly examined and the subject thoroughly investigated. Before final action, ample notice should be given to the governor of the State of Missouri, to the governor of the State of Kansas, and to the mayor of Kansas City, Mo., and the mayor of Kansas City, Kans., and to the county authorities and to the riparian owners, so that all the parties interested may have an opportunity to be heard. One or more days should be appointed for a hearing before the board, and all the parties interested should have an opportunity to be heard and to furnish statements and evidence, all of which should be submitted with the report of the board.

L. A. GRANT,
Acting Secretary of War.

[Eighth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 31, 1892.

Respectfully returned to the Secretary of War.

The act of July 13, 1892, provides that the appropriation made for the Missouri River shall be expended under direction of the Secretary of War in the systematic improvement of the river according to the plans and specifications of the Missouri River Commission, as approved by the Chief of Engineers.

The harbor lines established at Kansas City should be in harmony with the plans of the Commission for the general improvement of the river at that place; and, furthermore, if a board of engineer officers be constituted to examine and report on this subject, there will be no fund available from which the expenses of the examinations, surveys, hearings, and other necessary investigations can be paid.

For these reasons it is considered important that the matter should be placed in the hands of the Missouri River Commission, and it is respectfully recommended that the Commission be directed to take into consideration and report on the subject of these lines in accordance with the detailed methods set forth in the directions of the Secretary of War contained in the seventh indorsement.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Ninth indorsement.]

WAR DEPARTMENT, *January 7, 1893.*

Respectfully returned to the Chief of Engineers, with the suggestion that he call the matter to the attention of the Secretary of War.

L. A. GRANT,
Assistant Secretary of War.

[Tenth indorsement.]

WAR DEPARTMENT, *January 9, 1893.*

The Secretary of War concurs in the views and recommendations of the Chief of Engineers, and they will be carried out.

By order of the Secretary of War:

JOHN TWEEDALE,
Chief Clerk.

[Eleventh indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 10, 1893.

Respectfully returned to Lieut. Col. C. R. Suter, Corps of Engineers, calling attention to the eighth and tenth indorsements.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Twelfth indorsement.]

MISSOURI RIVER COMMISSION,
St. Louis, Mo., September 14, 1893.

Respectfully returned to the Chief of Engineers, U. S. Army, with report of this date.

CHAS. R. SUTER,
Lieut. Col. of Engineers,
President Missouri River Commission.

COMMUNICATION OF THE EXECUTIVE COMMITTEES OF THE STATE BOARDS OF HEALTH OF KANSAS AND MISSOURI.

KANSAS CITY, MO., *September —, 1892.*

DEAR SIR: At a joint conference of the executive committees of the State boards of health of Kansas and Missouri, held in this city on the 10th instant, to discuss the cholera situation, the resolutions, of which we inclose a copy herein, were unanimously adopted.

The slough mentioned in the resolutions is a standing menace to the health of both the Kansas cities; and as there is doubt as to which of the cities it legally belongs, neither city seems to think that it is justified in taking care of its sanitary condition. This being the case, it is at this time especially desirable that some method be adopted to better its condition from a sanitary standpoint at once and while there is no imminent immediate danger.

It was the opinion of this joint body that if the true river or harbor line should be definitely established, and the dispute as to the ownership of the ground thus settled, efforts would then be made immediately by the proper authorities to drain the slough.

We respectfully beg you to aid us in this precaution, which we think ought to be taken, by calling the attention of the honorable Secretary of War to the state of affairs and asking him to give such instructions to the Missouri River Commissioners as shall bring about a speedy location of the river line along the front of the two cities.

Hoping that you will aid us in this matter, which we deem of great and urgent importance to both Kansas City, Mo., and Kansas City, Kans.,

We are, with respect,

H. D. HILL, M. D., *Kansas,*
W. G. HALL, M. D., *Missouri,*
H. M. DOWNS, M. D., *Kansas,*
E. R. LEWIS, M. D., *Missouri,*
Committee.

(Signed by authority of the committee by E. R. Lewis.)

His Excellency, LYMAN U. HUMPHREY,
Topeka, Kans.

RESOLUTION ADOPTED AT A JOINT CONFERENCE OF THE EXECUTIVE COMMITTEES OF THE STATE BOARDS OF HEALTH OF KANSAS AND MISSOURI.

KANSAS CITY, MO., *September 10, 1892.*

At a joint conference of the executive committees of the State boards of health of Kansas and Missouri, held in this city to-day to discuss the cholera situation, the following resolutions were unanimously adopted:

"Whereas the West Bottoms or Packing House Slough, a low tract of land made or reclaimed from the Missouri River channel, and lying along the front of said river, between the cities of Kansas City, Mo., and Kansas City, Kans., is a standing and dangerous menace to the health of the two cities by being a cesspool of filth, refuse, and stagnant water, cut off from drainage to the river; and

"Whereas it is represented to us that the establishment of the true river front or harbor line would result in the immediate efforts to properly drain this slough and otherwise improve its sanitary condition; and

"Whereas the ownership of this tract of made or reclaimed ground is involved in dispute, being at present practically beyond the jurisdiction of either city, and uncared for by either:

"*Be it therefore resolved,* That a committee be appointed, to consist of Dr. H. D. Hill, of Kansas, Dr. W. G. Hall, of Missouri, and Drs. H. M. Downs and E. R. Lewis, health officers of Kansas City, Kans., and Kansas City, Mo., respectively, to draw up and present appropriate resolutions calling upon the honorable Secretary of War, through the governors of Missouri and Kansas, to give such instructions to the Missouri River Commissioners as shall lead to the speedy location of the river line along the front of the two cities.

"*Be it further resolved,* That Dr. R. C. Atkinson, of the Missouri State board of health, be requested to call upon Col. C. R. Suter, president of the Missouri River Commissioners, and urge upon him the necessity for the immediate consideration of this important subject."

Official:

M. O'BRIEN, M. D.,
Secretary of the Conference.

REPORT OF THE MISSOURI RIVER COMMISSION.

MISSOURI RIVER COMMISSION,
OFFICE OF THE PRESIDENT,
St. Louis, Mo., October 12, 1892.

GENERAL: I have the honor to submit the following report on the resolutions adopted September 10, 1892, by the executive committee of the State boards of health of Kansas and Missouri, presented to the honorable Secretary of War by letter from the governor of Kansas dated September 24, 1892, and referred to me for report by indorsement of the Chief of Engineers dated September 30, 1892; presented also by letter from the governor of Missouri under date of September 26, 1892, and referred to me by indorsement of the Chief of Engineers dated October 1, 1892.

The tract of land referred to lies on the south bank of the Missouri, just below the mouth of the Kansas River, and facing a slough dry at low water, except at the lower end. Considerable accretions have occurred here, largely aided by the dike of the National Water Works Company. The inclosed tracing shows the condition of affairs in February, 1892; but the high water of the present season has greatly added to the accretions as there shown.

The subject of establishment of harbor lines at Kansas City, Kans., and Kansas City, Mo., came before the Commission at their meeting of February 18, 1892, at which time delegations from each of the above cities and representatives of other interested parties were heard. The decision reached by the Commission at that time was that they had no power to establish harbor lines unless directed to do so by the Secretary of War.

At their meeting of March 26, 1891, certain bulkhead lines at Kansas City proposed by W. P. Van Aken had been approved by the Commission as not being prejudicial to the interests of navigation; and at the meeting of February 18, 1892, the Commission still maintained the same opinion. It was thought by them that the above bulkhead lines had received the approval of the Secretary of War; but subsequent correspondence (see indorsement of Secretary of War dated March 9, 1892, in letter from Secretary of War to Chief of Engineers, dated February 27, 1892), shows that this is not the case.

The lines shown on the inclosed tracing do not differ materially from the bulkhead lines proposed by Van Aken and approved by the Commission, and were considered satisfactory by the Commission, so far as navigation is concerned, when this matter was last considered. Whether this would be true at the present time, or whether they would meet the views of other parties concerned, I am unable to say. A resurvey of the locality and a hearing of interested parties would probably be necessary before any definite decision could be made.

Very respectfully, your obedient servant,

CHAS. R. SUTER,
Lieut. Col. of Engineers,
President Missouri River Commission.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

LETTER FROM THE GOVERNOR OF THE STATE OF MISSOURI.

STATE OF MISSOURI,
EXECUTIVE DEPARTMENT,
City of Jefferson, September 26, 1892.

DEAR SIR: I inclose copies of resolutions passed by a joint conference of the executive committees of the State boards of health of Kansas and Missouri, held in Kansas City, Mo., September 10. You will observe therefrom that "the true river front or harbor line" has not been definitely located at or near the boundary line between the two States, and that in consequence thereof the condition of the undefined territory is such as to be a menace to the health of the immediately surrounding country. I respectfully request that you direct the Missouri River Commission to locate at as early a date as possible the river line in front of the two cities.

Respectfully,

DAVID R. FRANCIS,
Governor.

Hon. STEPHEN B. ELKINS,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 1, 1892.

Respectfully referred to Lieut. Col. C. R. Suter, Corps of Engineers, in connection with previous papers sent him September 30, 1892, on same subject.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Third indorsement.]

MISSOURI RIVER COMMISSION,
St. Louis, Mo., October 12, 1892.

Respectfully returned to the Chief of Engineers, U. S. Army, with report of this date.

CHAS. R. SUTER,
Lieut. Col. of Engineers,
President Missouri River Commission.

REPORT OF MISSOURI RIVER COMMISSION.

MISSOURI RIVER COMMISSION,
OFFICE OF THE PRESIDENT,
St. Louis, Mo., September 14, 1893.

GENERAL: In accordance with your instructions contained in tenth indorsement, dated January 9, 1893, on communication of the governor of Kansas, dated September 24, 1892, the Missouri River Commission have carefully investigated the subject of harbor lines in front of Kansas City, Kans., and Kansas City, Mo. A public meeting was held at St. Louis, Mo., June 2, 1893, at which all persons interested were requested to express their views. Minutes of this meeting with copies of all papers filed are hereto appended.* The views of interested parties may be summed up as follows: The State of Kansas desires that the mouth of the Kaw River be left in the State of Kansas and that the shore line of 1826 be reestablished if possible. Kansas City, Kans., desires the same. The State of Missouri was not heard from. Kansas City, Mo., is indifferent. the drainage difficulties formerly complained of having been obviated by the construction of an intercepting sewer. Finally the riparian owners are mainly interested in as great a reclamation of land as possible, but above all to have a definite line fixed to which reclamation can be carried.

After full consideration of the subject, the Commission beg leave to report that in their opinion a reestablishment of the shore line of 1826 would be incompatible with the present direction and location of the river above, and also with the safe passage of the Hannibal and St. Joseph Railroad bridge at Kansas City, Mo.

They therefore respectfully recommend the harbor line exhibited on the accompanying map† as best fulfilling all the requirements of the situation. This line, it will be observed, leaves the mouth of the Kaw in Kansas, provides for a considerable amount of valuable reclamation, and at the same time gives a favorable direction of approach to the Hannibal and St. Joseph bridge. Map† appended, Appendix A (scale 1 inch = 2,000 feet), gives a general view of the locality and the proposed line. Map† appended, Appendix B (scale 1 inch = 250 feet), gives the location of the line in detail with the reference points from which it can be determined. These reference points with bearings and distances to marked points on the line are further described in Appendix C. Letters and references are the same on both maps.

Very respectfully, your obedient servant,

CHAS. R. SUTER,
Lieut. Col. of Engineers,
President Missouri River Commission.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

---

* Not printed. † Omitted.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 5, 1893.

Respectfully submitted to the Secretary of War.

The Missouri River Commission having had under consideration, in accordance with the instructions of the Secretary of War embodied in the seventh, eighth, and tenth indorsements on 1244-D-W. D., 1892, the subject of harbor lines on the Missouri and Kaw rivers in front of Kansas City, Kans., and Kansas City, Mo., has given the matter careful investigation and submits the within report and accompanying papers and drawings, to which attention is respectfully invited.

The Commission recommends for adoption the harbor lines shown by full black lines on the drawing marked Appendix B, the points on which line are designated by capital letters, beginning with "A," at the mouth of Dry Creek, in the northern part of Kansas City, Kans., and terminating at "B B," where the proposed harbor line intersects the revetted bank of the Missouri River. A description of these points, with bearings and distances from certain fixed reference points, is given in Appendix C.

I concur in the recommendations of the Commission, and recommend that the selected line be approved, and that the Secretary place his approval upon the drawing marked Appendix B.

Attention is invited to the communications of July 14 and 15, respectively, from the governor of Kansas and the mayor of Kansas City, Kans., requesting to be informed regarding the line proposed by the Commission before final action is taken on the matter by the Secretary of War.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *December 9, 1893.*

The harbor lines proposed by the Missouri River Commission, as shown on tracing marked Appendix B, are approved.

DANIEL S. LAMONT,
Secretary of War.

APPENDIX C.—DESCRIPTION OF REFERENCE POINTS.

POINTS DETERMINED BY THE CITY ENGINEERS OF KANSAS CITY, MO., AND KANSAS CITY, KANS., TO BE CONNECTED WITH THE RIVER SURVEY FOR DETERMINING POSITION OF THE KANSAS CITY HARBOR LINE.

a. Point in prolongation of the center line of Virginia avenue, 1,304 feet east of intersection of center lines of Virginia avenue and Third street, Kansas City, Kans.

b. Point in the prolongation of a line 34 feet south of and parallel to the north line of Washington avenue, 652 feet east from the center line of Third street, Kansas City, Kans.

c. On center line of Minnesota avenue, 508 feet east of center line of Third street, Kansas City, Kans.

d. Point in the prolongation of a line 20 feet north of and parallel to the center line of Ohio avenue, 450 feet northeast from the center line of James street, Kansas City, Kans.

e. Boundary monument on line between Missouri and Kansas, 19.6 feet south of arrow mark on the brick wall of the office of the Armour Packing Company; also 638.4 feet north of a point 125 feet south of the south line of Ninth street.

f. Bears north 70° 10′ east, 521.8 feet distant from boundary monument or point *e*. This point is on an unused trestle.

g. On line 16 feet east of and parallel to the west line of Santa Fe street, 332 feet north of north line of Eighth street, Kansas City, Mo.

h. Point is on prolongation of center line of Broadway, 364 feet from center line of Second street, Kansas City, Mo.

i. Point 35 feet north of south line of Front street, in prolongation of east line of Delaware street; also bears north 56° 4′ east, 1,017 feet from Point *h*, Kansas City, Mo.

j. Point on line between sections 32 and 33, and 590 feet north of intersection of center lines of Troost avenue and First street.

k. On line between sections 33 and 34, and 1,950 feet north of section corner 27-28-33-34, which corner is on Rochester avenue and alley between Garland and Anthony avenues, Kansas City, Mo.

l. Point on half-section line of section 27, and 1,985 feet north of center of section 27.

Eastern city limit is a north and south line, 1,445 feet east of point *l*.

POSITIONS OF POINTS OF REFERENCE ON HARBOR LINE IN FRONT OF KANSAS CITY, MO., AND KANSAS CITY, KANS.

The capital letters used to designate the points on harbor line are shown on the accompanying map. The small letters referred to and shown on the map are at points furnished by the municipal engineers. The bearings given are referred to the true meridian.

A. Upper end of harbor line is at mouth of Dry Creek, in the northern part of Kansas City, Kans. Point of beginning bears north 37° 22′ east, 334 feet distant from point *a*.

B. On prolongation of center line of Virginia avenue, 1,465 feet east of intersection of the center lines of Virginia avenue and Third street, Kansas City, Kans.

C. Point bears south 87° east, 533 feet distant, from a point at the north end of railroad trestle over Jersey Creek, which point bears south 33° west, 834.4 feet distant from point *a*.

D. Tangent point of Missouri River harbor line and the established line for the north bank of the Kaw River, bears north 74° 45′ east, 740 feet distant from point *b*.

G. Kaw River, north line. Point of beginning of tangent bears south 50° 52′ east, 675 feet distant from point *b*.

H. Kaw River, north line. Point at end of line and of tangent, at north pier of Kansas City, Argentine, and Independence Railway bridge across Kaw River, bears south 34° 22′ west, 1,415 feet distant from point G.

I. On prolongation of center line of Minnesota avenue, 1,690 feet east of center line of Third street, Kansas City, Kans.

J. Kaw River, south line. Line begins at outer end of dike at a point bearing north 53° 10′ east, 915 feet distant from south pier of Kansas City, Argentine, and Independence Railway bridge across Kaw River.

K. Point bears north 18° 45′ east, 2.055 feet distant from point *d*.

L. Kaw River, south line. Point bears north 18° 45′ east, 1,855 feet distant from point *d*.

M. Tangent point of Missouri River harbor line and line on south side of Kaw River, bears north 36° 15′ east, 1,762 feet distant from point *d*.

N. Point of intersection of State line between Missouri and Kansas, 2,360 feet north of boundary monument referred to as point *e*.

O. On prolongation of line 20 feet distant from, northerly and parallel to, the center line of Ohio avenue, 2,298 feet northeast from intersection of said prolonged line with the center line of James street.

P. Point bears north 20° 30′ east, 1,488 feet distant from point *f*.

Q. Point bears north 48° east, 1,608 feet distant from point *f*.

R. On prolongation of line 16 feet east of and parallel to the west line of Santa Fe street, 1,247 feet north of north line of Eighth street, Kansas City, Mo.

S. Point bears north 50° 35′ east, 1,640 feet distant from point *g*; also bears south 70° 50′ west, 1,072 feet distant from a point which bears south 51° 57′ west 592.3 feet distant from point *h*.

T. Point bears north 30° 55′ west, 118 feet from a point which bears south 51° 57′ west, 592.3 feet distant from point *h*.

U. On prolongation of center line of Broadway, 454 feet north of intersection of the center lines of Second street and Broadway, Kansas City, Mo.

V. Prolongation of east line of Delaware street, 95 feet north of south line of Front street.

W. Beginning point of tangent bears north 55° east, 845 feet distant from point *i*.

X. End of tangent is point on line between sections 32 and 33, which is also the center line of Troost avenue, and 1,712 feet north of meander corner. Meander

corner is 225.25 feet north of intersection of center lines of Troost avenue and First street.

Y. Point bears north 28° 25′ west, 430 feet distant from a point which bears south 62° 30′ west, 3,133 feet distant from point *k*.

Z. Point bears north 55° 43′ west, 553 feet distant from a point which bears south 59° 33′ west, 1,495 feet distant from point *k*.

A A. Point on line between sections 33 and 34 and 158 feet north of point *k*.

B B. Intersection of harbor line and revetted bank, bears north 53° 50′ east, 1,525 feet distant from point *k*.

APPENDIX Z Z.

ANNUAL REPORT OF THE CALIFORNIA DÉBRIS COMMISSION, 1893.

[Printed in House Ex. Doc. No. 16, Fifty-third Congress, second session.]

CALIFORNIA DÉBRIS COMMISSION,
San Francisco, Cal., November 15, 1893.

GENERAL: The California Débris Commission has the honor to submit the following report:

The Commission owes its existence to an act of Congress entitled "An act to create the California Débris Commission, and regulate hydraulic mining in the State of California," approved March 1, 1893. (Appendix E.)

The jurisdiction of the Commission, defined by section 3 of the act, extends to hydraulic mining in the territory drained by the Sacramento and San Joaquin river systems in California.

The Commission was organized in San Francisco on June 8, 1893, the senior officer becoming president, and the junior secretary and disbursing officer. Lieut. Gillette, Corps of Engineers, on reporting to the Commission for duty became, by authority of the Chief of Engineers, disbursing officer, relieving Maj. Heuer of his responsibility in money and property on November 8.

METHODS OF PROCEDURE.

On the date of its organization the Commission, as required by the act of Congress, adopted a set of rules for performance of business and instructions for applicants for permission to mine by hydraulic process. A copy of these rules and instructions is appended, marked A. These instructions are stated to be preliminary, and subject to changes as experience shall be found to require. A further schedule of requirements has been prepared, which fully outlines operations and instructions.

In cases where mining properties are large, and the hydraulic process is to be operated on a large scale, it is regarded as indispensable that the project be fully presented by written description and by full drawings. These drawings will show the position and extent of the storage reservoirs and the means proposed for restraint of detritus, and, generally, all that is necessary for a full record of the case. If a permit is issued subsequent mining operations will be recorded by a system of reports from the operators, and by inspection under direction of the Commission.

The greater number of applications will, however, come from owners of small properties, where two or three men are to operate the system, or where the miners are not in a position to furnish fully all desired information, either from want of knowledge or from want of means to hire suitable engineering advisers. These are cases where the output is small. Many are in remote parts of the country and work only for

two or three months of water supply during the year. In such cases the Commission expects to use its discretion in its requirements as to the form and fullness of applications. Inspection, however, of all mines in operation will be maintained.

As required by law, the Commission generally, by a committee of its members, has in every case visited the locality of the application. Some of these journeys require five or six days of arduous traveling in the mountains.

The number of applications for permission to mine has not been great. Of late they come in faster.

The new system of limitations and restrictions has to be studied by the miners. An application involves expense. If the application be granted further expense is involved in impounding arrangements. The system is a novelty; its workings are yet to be defined in practice. The miner is in the hands of the Commission; his permit, once granted, may be revoked in the discretion of the Commission; he is uncertain whether his practical devices for impounding will be understood; the uncertainty whether or not, even if all goes well with the Commission, he may not be involved in litigation. These and other circumstances are sufficient to account for hesitation and delays.

The Commission has no means as yet of estimating the number of applications with which it will have to deal. In 1880 more than 400 hydraulic mines were reported to be in operation within the drainage area of the Sacramento and San Joaquin rivers.

The assessors of the mining counties reported in 1880 over 10,000,000 inches of water used in mining. The State engineer's estimate of the quantity of gravel mined in that year exceeded 38,000,000 cubic yards. The amount of workable gravel yet remaining is indeterminate. Competent authorities place it at several hundred million cubic yards.

It is not supposed that the Commission will have to deal with all, or nearly all, of this great mass; but, on the other hand, it is not possible yet to estimate the percentage to come under our control. Much depends upon the working of the system of control during the coming year.

It is probable that the increased expenditures, and the restrictions upon freedom of operations involved by the new system of regulation, may act to make mining in many cases less profitable than formerly, thereby reducing the magnitude of the output and the number of applications.

A list of all applications presented to the Commission is appended, marked B. Upon this list are shown the locality of mine, brief, and date of application, and action, if any, taken by the Commission.

HYDRAULIC MINING.

The following are sections of the State code of laws in force in California:

SEC. 1424. The business of hydraulic mining may be carried on within the State of California wherever and whenever the same can be carried on without material injury to the navigable streams or the lands adjacent thereto.

SEC. 1425. Hydraulic mining, within the meaning of this title, is mining by means of the application of water under pressure, through a nozzle, against a natural bank.

This definition is accepted by the act of March 1, 1893, which, in section 8, provides that "hydraulic mining, and mining by the hydraulic process, are hereby declared to have the meaning and application given to said terms in said State" (California).

This method of mining was practiced for many years on a large scale within the territory over which the jurisdiction of the Commission now extends. Large sums of money were invested by miners and capitalists in construction of reservoirs in high altitudes in the Sierra Nevada; in canals of many miles in length, traced along the steep flanks in the mountains; in long systems of wrought-iron conduits, ending at the ground to be worked, and in trenches, outlet tunnels, and sluices, in which the gold was gathered, and through which the detritus of stones, gravel, sand, and clay was carried away from the mines.

A system of wonderful efficiency was developed from these elements by which it became practicable to wash with profit gravel containing a few cents per ton. But for this system the great placer deposits must, for the most part, have remained undisturbed for the reason that, while exceptional deposits of gravel lying close to the bedrock in some cases produce as much as several dollars per cubic yard, the average product from the top to the bottom of these gravel deposits, which are often several hundred feet in height, is but a few cents per cubic yard, and not enough to repay the cost of mining by any other process than the one hereinbefore described.

But with a great output of gravel, say perhaps as much as 10,000 cubic yards per day, effected by large quantities of water under great pressure, which excavated the gravel and removed it, under the direction of a few men, there was probably a profit even when the product did not exceed 10 cents per cubic yard.

So it came about that everywhere in the mining territory where auriferous deposits of sufficient extent were found so situated as to be accessible to water supply, and at sufficient elevation above the rivers to give fall to the sluices adequate to carry off the detritus, monitors were at work washing down hills and transferring them to the beds of adjacent streams, down which they were moved by freshets to the plains and water courses of the valleys, whereon and wherein large deposits were made.

LITIGATION.

The private and public injuries thus created and perpetuated in increasing degree gradually developed opposition among the valley people, and gave rise to litigation, which eventuated in an injunction by the circuit court of the United States in 1884, forbidding a certain mine to use the beds of streams as a dumping ground for mining detritus. This injunction remains in force. Its date marked the beginning of a period of decline, and, afterwards, suspension of hydraulic mining operations, which, with exceptions of more or less importance, yet lasts. Reworking of tailings in beds of streams has, however, been continued during the intervening years.

In the course of this controversy, which lasted over a number of years, there grew up in the Sacramento Valley an organization, entitled the Anti-débris Association. It is composed of delegates from counties or districts injuriously affected by hydraulic mining, and is supported by funds procured by taxation in four or five counties situated in the valley. This association has its attorneys and inspectors. It collects information and aids in prosecution of cases.

The United States also appears in its own courts as complainant, and has asked for injunctions against parties charged with depositing mining detritus not only in the beds of streams tributary to navigable

waters, but elsewhere, to the alleged injury of navigation. Two cases have been decided in the circuit court for the ninth circuit, northern district of California; one in the matter of the North Bloomfield Gravel Mining Company, opinion dated October 5, 1892, the other in the case of the Brandy City mines, under the same date.

These cases touch closely the operations of this Commission as defined by the act of March 1. The reason assigned for refusing an injunction against the North Bloomfield Company, and those assigned for granting an injunction in the second case, mark an important distinction between detritus impounded in the beds of streams subject to freshets, tributary to navigable waters, and storage in reservoir sites not traversed by natural water courses. These decisions are appended, marked C.

IMPOUNDING SITES.

Mining operations have disclosed the fact that the deposits of auriferous gravel are in the beds of extinct rivers, lying high on the western flanks of the Sierra Nevada, one to several thousand feet higher than the adjacent modern rivers. It is assumed that existing rivers have cut their channels since the period during which the ancient rivers became first filled, and then obliterated, by overflow of eruptive matter. The excavation of these channels in past years by the hydraulic process, to the extent of many million cubic yards, has left large cavities, now available for refilling with new detritus. These pits are admirable reservoir sites. They are bounded by side walls of rock, often from one hundred to several hundred feet in height. In width they vary very much, being in places as much as a thousand feet. No natural water course traverses them and the natural drainage is of little extent. To refill them is to restore them to the state of nature, making them no more a source of contribution of earthy material to the streams than are the natural slopes adjacent. If barriers to restrain are necessary they are so only during the process and duration of mining. The barriers may afterwards decay, but the detritus remains impounded. This circumstance was recognized by the court in its refusal to enjoin the North Bloomfield Company, and it is the key of the decision.

It is, however, true that these sites are not profitably available for storage in quantities at all approaching the contents as they were in a state of nature. Some of them may not be at all practicable sites for any great amount of storage. This is due to the fact that often there is not fall enough from the gravel to be mined to the level of the reservoir site. A fall of at least 100 feet to the mile is generally necessary to enable the sluices to carry the detritus. Much more fall than this is used when available. The fall diminishes as the reservoir becomes filled. The limit of profitable mining may be reached before the best ground in the mine, that which lies lowest, is broken.

Under such circumstances the miner has a resource in elevating the gravel. This is done by using a large portion of his water power to raise the material to a higher level. It is practiced to some extent. It lessens very much the quantity that can be worked in a given time by a given water power. Nevertheless it has been used to lift to heights as great as 80 feet.

A second point worthy of attention in the decision in the North Bloomfield case relates to the condition of escaping water, wasted after it performs its full mining duty. The court practically holds that

if the sand and gravel be restrained it is not to be insisted that the residual water shall be clear, the evidence proving that the finely divided clay, which gives color to the water, is nowhere deposited in appreciable quantity.

Apart from these reservoir sites and from such natural sites as may fulfill equivalent conditions of safe storage there remain for deposit the beds of natural water courses. Storage here is not so favorable. These streams are subject to freshets. They have falls of many feet to the mile. In some cases the streams in freshets may be termed torrents. Two cases may be distinguished, first, where the barriers are overtopped, and second, where a separate channel is made. Overfall barriers are subject to danger of destruction by violence of flood, and, if built in wood, sure to decay in a few years; so sooner or later there comes a time when they no longer retain material deposited behind them.

Independently of these considerations the equilibrium of a river bed of movable materials, over which unequal flowage occurs, a rivulet at one season and a torrent at another, can not be regarded as constant under these different circumstances. There is probably no constant slope of equilibrium. It varies with the flowage. While, therefore, a barrier placed across the bed of such a stream must restrain, it can hardly be said to restrain all, and perhaps not nearly all, deposits. The wider the bed the smaller the freshets, and the thinner the height of overfall the more effectually will the barrier restrain.

A modification, which passes the flowage in a separate channel and permits no overfall at the barrier, relieves the structure from the more imminent perils. Yet the water course passes over and through the reservoir and while the barrier, so long as not overtopped, may be safe, yet uncertainty exists as to the efficiency of storage after a time, due to causes already mentioned. Moreover, mining ceases in time. Its residuum remains. In what way are natural decay or particular damage to a restraining system to be repaired? If the stream has little or no natural drainage the case is simpler.

Deposits in beds of streams subject to freshets is quite fully discussed in Justice Gilbert's decision on the Brandy City mine.

The gold-mining industry is important in its bearing upon the general interest of the United States as well as upon local property, and the risk is so great that unnecessary or ill-advised restrictions and limitations upon mining activities are to be carefully avoided. On the other hand, the great amount of material that has to be handled and stored by the hydraulic process to get a little gold makes the problem of secure impoundment and of protection to navigable waters and adjacent lands one of difficulty and seriousness.

Between these opposing and delicate conditions this commission has to pick its way.

REWORKING OF DETRITUS.

The definition of hydraulic mining has been given. It is mining by water under pressure directed against a natural bank. It has also been mentioned that throughout the period of controversy old tailings have been reworked without restriction by the courts, or opposition of the people of the valleys. This work does not come within the definition of hydraulic mining. No nozzle is used and water is not used under pressure. The tailings are shoveled into sluices and the gold is separated through the shifting agency of running water, by the aid

of riffles, and amalgamation with quicksilver. The effect is to move material from one place to a lower position. The work has hitherto been confined to the beds of streams filled with tailings. The operation does what the freshets do, that is, it moves material downstream. There is no great objection to this process confined to beds of streams. Doubtless it disturbs and transports some finer matter which might never have been otherwise displaced, but this is of no particular importance.

The case is somewhat different when applied to deposits impounded in beds of streams or elsewhere. It is quite practicable, and, so far as known, permissible under the law, to work by sluices tailings which have been kept out of the river beds by barriers or otherwise, and to deliver them reworked to the beds of streams, in positions from which damage to navigable waters may result.

As the law stands, so far as the act of March 1, 1893, is concerned, while the hydraulic miner is required to deposit his tailings securely, the sluice miner may, perhaps in a legal manner, remove the tailings from the reservoir without any obligation to restrain them in their new positions.

Perhaps the scale of this kind of work may be so small as to be unworthy of notice, and perhaps if it should become important the courts would intervene by injunction, under section 6 of river and harbor act, approved September 19, 1890.

IMPROVEMENT OF THE RIVERS.

In addition to its duties for the regulation of hydraulic mining the Commission is required by the provisions of the act to mature plans for the improvement of the rivers whose channels have been injured by débris resulting from mining operations, and to survey and determine the practicability of storage sites in the tributaries or in the plains, basins, swamps, and tule lands adjacent to said rivers for storage of water or débris, or as settling reservoirs in connection with the improvements of the rivers, by preventing deposits of débris therein, or for affording relief in flood times, or for flushing reservoirs in low-water season, and in general to devise methods whereby hydraulic mining can be carried on without injury to the navigable rivers. While mining operations are being carried on under its authority, the Commission is further required to make surveys of the rivers from time to time to ascertain the effects therein of said operations, and also the effects of erosion, natural and otherwise.

From the date of its organization the attention of the Commission has been fully occupied with matters relating to the resumption of hydraulic mining, and to the individual duties of its members, and no time has been afforded for the consideration of the extensive measures outlined above. During the coming season it is proposed to make such surveys and examinations as may appear necessary to fulfill the requirements of the law.

For a number of years past, under appropriations made by various river and harbor acts, operations have been carried on upon the improvement of the rivers injured by mining débris, with a view of affording a navigable depth of channel adapted to the present demands of commerce. In addition, plans of improvement have been recommended and estimates presented by boards specially convened to consider the subject. Under the provisions of the act approved October 1, 1888, a commission was appointed to investigate the hydraulic min-

ing question, and in connection therewith to present plans for the improvement of the rivers. This commission recommended the treatment of the shoal places in the Sacramento and Feather rivers; the construction of a dam at De Guerre Point, on the Yuba, for the purpose of restraining the débris lying in the stream above, and restriction works on the Yuba plains below the foothills.

The improvement of the Sacramento and Feather rivers was again made the special subject of report by a board of engineers, under the provisions of the river and harbor act of September 19, 1890. The recommendations of this board included the improvement of the shoal places in the Sacramento and Feather rivers and restriction works on the Yuba above Marysville.

The maps of all the surveys made in connection with the improvements made and proposed are at the service of this Commission.

The balance on hand from the appropriation of $15,000 made by the act of March 1, last, for the expenses of the Commission is $13,828.44. It is estimated that an additional amount of $20,000 will be required to make the surveys and investigations required by the act.

In regard to the provisions of section 25 of the act of March 1, 1893, in which the recommendations contained in Ex. Doc. (H. R.) No. 267, Fifty-first Congress, second session, and Ex. Doc. (H. R.) No. 98, Forty-seventh Congress, first session, are adopted by Congress, and directed to be made the basis of operations, the Commission desires to say that the restraining barrier described in these documents, situated at or near De Guerre Point on the Yuba River, is considered an advisable construction, to be soon undertaken for restraint of detritus now in the beds of the streams, in furtherance of the project for the improvement of the Sacramento and Feather rivers.

A suitable appropriation for this work will be $300,000.

REMARKS.

While, of course, and of right, any error in fact or law, or judgment, committed by the Commission may be corrected in the courts, the Commission is, by the act of Congress, left very much to its own discretion, and is compelled to rely mainly upon its own judgment. Being unprovided with a legal adviser it is of necessity compelled to its own conclusions in deciding certain legal points in despite of the fact that its members can not lay claim to legal knowledge or experience.

An illustrative case has occurred: A party presented an application in which he stated that he was the owner of the mining property which he desired to mine. The attorney of the Anti-Débris Association controverted the proposition that the applicant was the owner, and offered to present proof that the property had been sold to another party by the United States marshal, and that this party held the deed. The attorney urged that the Commission is required by the act to take notice of this fact, and to refuse a permit for the reason that the law confines permits to proprietors. On the other hand the applicant was in possession of the property, claiming to hold by a deed from the sheriff of Nevada County, who had sold the property to meet unpaid taxes.

The Commission considered these points. It appeared first that the Commission is not empowered, and is not, by its constitution, capable of deciding disputed questions of title—that the court of law alone can decide such questions; that if the Commission undertakes to do so, its operations may be clogged and nullified in many cases by appearance of a contestant, for many mining properties are in dispute.

In view of all the conditions, the Commission decided upon a rule of action to the effect that the party in possession, alleging in his verified application that he is the owner, is to be recognized as owner until the courts of law shall have determined otherwise.

Appendix D is a copy of an act of the legislature of California, providing for a State débris commissioner, and defining his duties.

Mr. John F. Kidder, C. E., has been appointed. He has accompanied the Commission in visits to a number of mines, and has attended some sessions of the Commission in San Francisco.

Respectfully submitted.

G. H. MENDELL,
Colonel, Corps of Engineers.
W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.
W. H. HEUER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

APPENDIX A.

RULES AND INSTRUCTIONS.

SAN FRANCISCO, *June 8, 1893.*

The California Débris Commission, appointed under the act of Congress approved March 1, 1893, publishes for the information of all concerned sections 9, 10, 11, and 12 of the law which governs in the matter of presentation of petition and proceedings thereafter:

SEC. 9. That the individual proprietor or proprietors, or in case of a corporation its manager or agent appointed for that purpose, owning mining ground in the territory in the State of California mentioned in section three hereof, which it is desired to work by the hydraulic process, must file with said Commission a verified petition, setting forth such facts as will comply with law and rules prescribed by said Commission.

SEC. 10. That said petition shall be accompanied by an instrument duly executed and acknowledged, as required by the law of the said State, whereby the owner or owners of such mine or mines surrender to the United States the right and privilege to regulate by law, as provided in this act, or any law that may hereafter be enacted, or by such rules and regulations as may be prescribed by virtue thereof, the manner and method in which the débris resulting from the working of said mine or mines shall be restrained, and what amount shall be produced therefrom; it being understood that the surrender aforesaid shall not be construed as in any way affecting the right of such owner or owners to operate said mine or mines by any other process or method now in use in said State: *Provided,* That they shall not interfere with the navigability of the aforesaid rivers.

SEC. 11. That the owners of several mining claims situated so as to require a common dumping ground or dam or other restraining works for the débris issuing therefrom in one or more sites may file a joint petition setting forth such facts in addition to the requirements of section 9 hereof; and where the owner of a hydraulic mine or owners of several such mines have and use common dumping sites for impounding débris or as settling reservoirs, which sites are located below the mine of an applicant not entitled to use same, such fact shall also be stated in said petition. Thereupon the same proceeding shall be had as provided for herein.

SEC. 12. A notice specifying briefly the contents of said petition and fixing a time previous to which all proofs are to be submitted shall be published by said commission in some newspaper or newspapers of general circulation in the communities interested in the matter set forth therein. If published in a daily paper, such publication shall continue for at least ten days; if in a weekly paper, in at least three issues of the same. Pending publication thereof said commission, or a committee thereof, shall examine the mine and premises described in such petition. On or before the time so fixed all parties interested, either as petitioners or contestants,

whether miners or agriculturists, may file affidavits, plans, and maps in support of their respective claims. Further hearings, upon notice to all parties of record, may be granted by the commission when necessary.

The commission also publishes the following suggestions, instructions, and information for present guidance of those concerned. These instructions are subject to such modification as experience may suggest.

The petition must, in addition to fulfillment of the requirements of the law, contain, or be accompanied by, a full description covering the following points and by such maps as may be required for illustration of the question, namely:

The name, location, and extent of the mining ground; the route of travel thereto; the river which the drainage of the mine reaches and the names of the tributaries which it follows; the height of the bank to be mined; the character of the gravel; the source of the water supply; the length, fall, and dimensions of the ditch; the length of the mining season; the number of inches of water proposed to be used and under what pressure; the daily duration of mining proposed, whether for twenty-four or fewer hours; the fall of the sluice in 12 feet; dimensions of sluice and the amount of gravel to be handled in an hour; the character of restraining barriers existing or proposed; a description of the site for impounding detritus; its area and capacity; position and character proposed for the barrier.

Brevity and clearness are to be studied in these descriptions.

The above-stated information may be sufficient to enable the Commission, in some cases, to dispense with maps, but in all cases of importance maps of the mining ground and of the reservoir sites will probably be necessary, and in all cases will probably expedite the action of the Commission. The Commission prefers, for expedition, but does not at present insist, that each case should be presented by a mining or civil engineer capable of giving necessary information.

It will expedite matters if all the miners in one particular locality will prepare and present their petitions as near as possible at the same time, in order that the mines may all be examined during one visit of the Commission.

In cases of a joint petition contemplated in section 11, there should be a separate statement from each individual mine as to its proposed output, amount of water, etc., the same as provided for a single petition.

All maps, plans, petitions, or writings of any description on file in the office shall be open for examination by any interested party.

On a day following the date fixed in the advertisement, provided in section 12, the Commission or a committee thereof will attend in its office to meet the petitioners and contestants, for the purpose of gaining, by inquiry, such explanation as may be necessary for a full understanding of the case.

The Commission does not invite oral addresses and prefers that all questions submitted for its consideration be presented in writing.

The office of the Commission is for the present established in room 89, Flood building, San Francisco.

All communications should be addressed to Maj. W. H. Heuer, Corps of Engineers, room 89, Flood building.

APPENDIX B.

Table showing applications to mine by the hydraulic process.

[Received by the California Débris Commission.]

No.	Name of mine.	County.	Applicant.	Approximate amount of gravel proposed to mine.	Mine drains into tributary of—	Nature of tailings reservoir proposed for present use.	Its approximate capacity.	Date of application.	Plan approved by Commission.	License issued.
				Cubic yards.			*Cubic yards.*			
1	Kelly Hill	Butte	Mooer & Boyd	1,000,000	Sacramento River.	Dam 30 feet high, in dry ravine; of rock, brush, and earth, with side spillway cut in rock.	200,000	Aug. 2	Oct. 3	
2	Farrel	Nevada	Eureka Lake and Yuba Canal Co., consolidated.	212,000	Middle Yuba River.	Dam 12 feet high, of earth and logs across the mouth of an old hydraulic pit.	212,000	Aug. 11	Work already built.	Sept.
3	Omega	do	N. C. Tully	2,160,000	South Yuba River.	Dam 80 feet high, in Scotchman Creek, built of brush and gravel, with side spillway cut in rock.	1,000,000	Aug. 16		
4	Richmond Hill and Saw Pit Flat.	Plumas	Good Hope Mining Co.	300,000	Middle Feather River.	Rock dam in Onion Valley Creek.		Aug. 24	Petition incomplete.	
5	Brandy City	Sierra	A. Steinberger	1,520,000	Middle Yuba River.	Brush and earth dam across mouth of old hydraulic pit.	1,940,000	Sept. 19	Oct. 25	
6	Blue Nose	Plumas	B. Below	50,000	Middle Feather River.	Stone dam in Hopkins Creek.	50,000	Sept. 19		
7	Blue Gravel Placer Mine.	Yuba	Excelsior Water and Mining Co.	604,000	Yuba River	Old hydraulic pit, with tunnels stopped with rock.	2,885,000	Sept. 27	Work already built.	Oct. 17.
8	Illinois Gold Gravel Mine.	Plumas	Buckley & Hillman.	35,000	North Yuba River.	do	35,000	Sept. 29		
9	New York Gold Gravel Mine.	Sierra	Westall & Hughes	484,000	South Yuba River.	Brush, log, and earth dam in Howard Creek, with side spillway in rock.	240,000	Oct. 1		
10	Corbiere & Bean	Butte	Corbiere & Bean	2,000	North Yuba River.	Rock dam, 10 feet high, in Hampshire Creek.	2,000	Oct. 9		
11	Phœnix Gold Gravel Mine.	Sierra	W. A. and M. E. Schofield.	1,660,000	do	Dams in Whisky Creek and North Fork of Slate Creek.		Oct. 14		
12	Eureka mining claim.	do	Eureka Mining Co.	553,000	do	Dams of timber, in Sawmill Ravine.		Oct. 16		

Table showing applications to mine by the hydraulic process—Continued.

No.	Name of mine.	County.	Applicant.	Approximate amount of gravel proposed to mine.	Mine drains into tributary of—	Nature of tailings reservoir proposed for present use.	Its approximate capacity.	Date of application.	Plan approved by Commission.	License issued.
				Cubic yards.			*Cubic yards.*			
13	Craycroft Hill placer mining claim.	Sierra	Craycroft Mining Co.	140,000	North Yuba River	Dams of timber, in Hughes and Davidson ravines.	....	Oct. 16	....	
14	Excelsior hydraulic mining claim.	....do	Excelsior Mining Co.	277,000	....do	Dams of timber, in Eagle Gulch and Smith's Flat.	....	Oct. 16	....	
15	Spanish Ranch ...	Plumas ...	Quincy Mining and Water Co.	4,900,000	North Feather River.	Dams of timber, in Spanish Creek, with spillways in rock; also old hydraulic pits.	4,900,000	Oct. 18	....	
16	Polar Star Placer Mine.	Placer	John Spaulding...	605,000	Bear River	Stone and gravel dam, in Little Bear River, with spillway.	605,000	Nov. 1	....	
17	Denmire	Sierra	A. Denmire.......	3,100	North Yuba River	Dam in dry ravine........	3,100	Nov. 6	....	

APPENDIX C.

JUDICIAL DECISIONS.

In the circuit court of the United States in and for the ninth circuit, northern district of California, Hon. Wm. B. Gilbert, judge.

UNITED STATES, COMPLAINANT,
vs.
THE NORTH BLOOMFIELD GRAVEL MINING COMPANY, DEFENDANT. } No. 7865.

WEDNESDAY, *October 5, 1892.*

GILBERT, J. This is a suit for an injunction brought by the United States as complainant against the defendant corporation. The essential averments of the bill are that the mining company is engaged in hydraulic mining in Nevada County and dumping its débris and tailings in such a way that the same flow into the South Yuba River, a tributary of the main Yuba River; thence into the main Yuba River; thence into the Feather River, and thence into the Sacramento. That the Yuba River is navigable from Marysville to its mouth, and Feather River is navigable from the mouth of the Yuba to the Sacramento, and that the Sacramento is navigable from its mouth to the mouth of the Feather. That heretofore extensive hydraulic mining had been carried on upon the western watershed of the Sierra Nevada Mountains, which had done great injury to the navigable streams referred to, and that the hydraulic mining, as conducted by the defendant, had done great injury to said navigable streams, and the continuation of it will further materially contribute to the injury complained of.

The answer of the defendant denies that it was dumping débris or tailings from its mining operations so that the same flowed into the said rivers; but it alleges that it has erected extensive impounding works by means of which it impounded upon its own lands and within its own mines all material likely to injure the navigation of said streams, and that it would continue to impound such mining material so long as it should continue its mining operations, and that the same would remain permanently impounded and restrained in such a manner as not to injure the navigation of such streams. A large amount of testimony was taken on behalf of the respective parties, and the case is now to be decided upon final hearing.

* * * * * * *

It remains to be considered whether, under the allegations of the bill and the evidence introduced on behalf of the respective parties, an injunction should issue as prayed for.

The operations of the mine of this defendant corporation was enjoined by a decree of this court in 1884, in the suit of Woodruff *vs.* North Bloomfield Mining Company, and that injunction still remains in force. In the decree an intimation was made that if in the future the defendant corporation should show to the court that it had constructed impounding reservoirs which would successfully impound its mining débris the decree might be modified so as to permit the operation of the mine. The defendant, since that decree and before the commencement of this suit, had established and was using the system of impounding works referred to in its answer to the bill. The question of fact now to be determined is whether or not, with the use and operation of the impounding works, mining débris escapes from the defendant's mine into the navigable waters of the Yuba, the Feather, or the Sacramento so as to tend to impair or injure the navigability of those streams. It becomes necessary, therefore, to carefully consider the construction and operation of the impounding device. At the time of the injunction in 1884 the North Bloomfield Mining Company, by the use of its monitors and its system of placer mining, had made an excavation on its grounds which was in length nearly a mile, in width from 500 to 1,000 feet, in depth varying from 150 to 400 feet.

There was no considerable stream of water running through this excavation, and there was no natural outlet to the same. The tailings and débris from the mine had been discharged through a shaft which was sunk through solid rock near the center of the excavation. This shaft was 80 feet in the perpendicular and connected with a tunnel cut also through the solid rock, a distance of nearly half a mile, and opening into Humboldt canyon, which lies considerably below the level of the excavation. The total cost of the tunnel and shaft was in the neighborhood of $500,000. The impounding works were constructed by utilizing the excavation, the shaft, and the tunnel. The impounding area is divided by a dam into two impounding basins, each of about 20 acres in extent, which may be called the old and the new basins. The surface of the old basin lies at an altitude of about 100 feet above that of the new. The mining operations are all carried on at the upper end of the excavation. The mining is done upon two levels or benches, one at an elevation of about 100 feet above the other. The débris from the upper mining level is carried on that level to

the old impounding basin. The débris from the lower mining level is intended to be impounded in the new basin. Near the lower end of the old basin an inclined shaft has been sunk to connect with the tunnel, and its use is to allow the escape of water after all material likely to injure navigation shall have been deposited in the basin. A similar outlet is made in the new impounding basin, and both these outlets are cribbed up from the bottom, so that a thin sheet of water from the surface only can escape. The operation of the old reservoir has been tested and a considerable amount of débris has been deposited within it.

The dam which separates the basins is constructed across the excavation and prevents the débris from running back from the old basin into the new basin and the lower levels of the mine. The operation of impounding has been conducted in the following manner: The débris from the mining on the upper bench, consisting of gravel, sand, and comminuted clay, together with sufficient water to carry the same, has been conducted by a sluice, with a tolerably swift current, down to the upper edge of the old impounding reservoir, and there discharged into the pond or lake. It has been found that the heavy material is deposited first, the lighter sand and gravel are carried somewhat farther, and when the current strikes the body of water in the pond nearly all the remaining material carried by the water is deposited, forming a bench across the upper end of the depositing pool, which presents an almost perpendicular wall from the surface to the bottom. The water on striking the pool is diffused through it and its current apparently ceases. It has the effect to raise the water in the pool and to cause a constant outpour from its surface over the edges of the lower crib.

There are three objections urged against the operation of this impounding reservoir: First, that it does not successfully remove from the water the material which is carried in suspension, and that the water which escapes by the cribs takes with it material which becomes deposited in the lower streams and injuriously affects the navigability of the same. Second, that the dam across the excavation is not of durable material and is liable to break. Third, that the cribs are liable to break or decay, and the impounding material may thus escape into the streams below.

Upon the first of these objections the evidence, although voluminous, is not to any considerable extent conflicting. The water that escapes through the cribs is discolored with very fine particles of comminuted clay which are held in suspense. It is impossible that water that has once fairly come to rest in the pool and has then been drawn off from the surface through the cribs should carry with it any sand or anything other than the lightest material. The evidence goes to prove that the fine clay held in suspense in the water, and which causes its discoloration, is of specific gravity very little greater than water, and that it will remain in suspense so long as the water moves with the velocity of a mile in two hours.

The evidence further shows that this material is carried in a state of suspense through the Yuba, the Feather, and the Sacramento rivers, and into the ocean. It does not appear that at any point on those streams the water comes to rest or the clay which it carries is deposited in an appreciable quantity.

After taking into consideration all of the evidence, I am convinced that after the water which conducts the mining débris shall have once come to rest so as to deposit all the sand and heavier material that is carried in suspense, leaving only the light, floculent particles of clay, which give it its color, no material will be subsequently deposited from it unless it is brought to rest and so remains for a period longer than it has remained at rest in the impounding pool.

Second. Is there danger to be apprehended from insufficiency of the dam which separates the old from the new impounding basin? The dam is constructed of brush and small trees, carefully laid so that the butts form the outer wall. It is made by layers, as the pool fills up and as the deposited débris requires it. The interstices between the layers of brush are filled in with the gravel, sand, and clay deposited from the flume. The dam as it now stands presents a wall nearly 100 feet high, which seems to be a compact, solid mass of gravel, sand, and clay, with the brush interwoven so as to hold in place. If there were great pressure upon this dam, if it were a dam across a torrential stream, if its breaking or carrying away would discharge into the stream below the débris that has accumulated, it would appear to be clearly insufficient for the purpose intended, but the evidence together with a personal inspection of the dam convinces me that there is no great pressure upon the dam. The heavy material deposited has not only accumulated about the dam but for a considerable distance below, and the mass appears to be now in the process of recementation and solidifying, which already, to a considerable extent, has restored it to the condition of the material in the surrounding hills. If this dam should break it is difficult to see where injury could result, for the impounded material, if it moved at all, could only escape into the new impounding reservoir. It is plain that there is no danger from winter torrents. The mine is not in the bed of a mountain stream. The amount of water which naturally falls into this excavation is small, and even in a winter torrent it must either all escape by the cribs or simply accumulate and form a lake within the walls of the excavation.

It remains to be considered whether there is danger to the navigability of the streams from the breaking, decaying, or destruction of cribs. The cribs are built of logs, about a foot in diameter, notched at the corners and laid in log-cabin style, lined within with heavy planks, tightly nailed, and covered on the outside with planks in a similar manner, so that the opening within the clear is about three or four feet square. It is claimed by the defendant that this material will not decay so long as it is kept moist by the surrounding mass. I do not think that contention is well established by the evidence. The cribs, in time, will decay, but they will last for many years, and they will doubtless considerably outlast the use of these pools for impounding reservoirs. After the pools shall have been filled up with mining débris, and these cribs shall no longer be the outlet of the water of the mine, I do not perceive any harm that can come from their decaying. By that time the impounded material must have become, to a large degree, compact and solidified, so that the caving in of any considerable portion of it need not be expected; and if it should cave in, it is plain to my mind that the result would be simply to choke up the shaft and permanently close the same. This view is supported by the history of the use of the shaft heretofore. It is proven that the sudden discharge into the shaft and tunnel of a greater amount of débris than the water could carry away has resulted in a choking up of the outlet, and that the mass of material and water above has simply served, by their pressure, to increase the difficulty of removing the material and reopening the shaft. In short, the danger to be apprehended from the operation of the North Bloomfield Mine, with its impounding reservoirs as constructed and used and intended to be used, is so remote and improbable that the court is not justified in enjoining the use of the property and thereby interdicting a valuable industry.

In arriving at this conclusion, I am not unmindful of the great damage to navigation that has heretofore resulted from the deposit of mining débris, nor of the important interests that are involved, but I am convinced that in the case of this particular mine the contingency has arisen which was contemplated in the decision of this court in the mining-débris cases, in providing that the decree might thereafter be modified upon a showing to the court that a plan to obviate the injuries had been successfully executed.

The injunction will be denied.

In the circuit court of the United States in and for the ninth circuit, northern district of California.

UNITED STATES,
vs.
CHARLES H. LAWRENCE *et al.* } No. 10738.

WEDNESDAY, *October 5, 1892.*

GILBERT, *J.*: The bill filed by the complainant in this case is similar to the bill in the case of the United States *vs.* North Bloomfield Mining Company, and the defenses here made are substantially the same as those made in that suit.

It is claimed in the answer of the defendants that they have established a system of impounding works whereby all material liable to injure the navigability of the streams referred to in the bill is impounded and retained upon the premises and does not enter the navigable streams.

The mining débris from the defendant's mines escape through a shaft 90 feet deep sunk in the lower level of the mine; thence it is discharged into a tunnel 3,000 feet long, which empties into Canyon Creek. About a quarter of a mile below the exit of the tunnel a dam has been constructed across the channel of the creek. This dam is a crib dam composed of heavy fir logs pinned together at the corners and raised to the height of 28 or 30 feet. The interior of the crib is filled with stones. The dam has caused the water to set back to a considerable distance in the stream, creating a pond. Into the upper portion of this pool the mining débris is carried from the tunnel. During the time this restraining devise has been used, the mining débris has worked its way down toward the dam and filled up some portion of the reservoir. The exact proportion of the pool which yet remains to be filled is not definitely fixed by the testimony, but the evidence would indicate that there still remains an impounding pool extending back from the dam a distance of about 1,000 feet, in which no portion of the débris or material discharged appears visible above the surface of the water.

It appears also that the current of the water in the dam is sluggish, and during the operation of the mine and the discharge of débris into the pool there has been an appreciable current in the water, but the evidence does not show that any considerable amount of débris calculated to lodge in the streams below or to injure their

navigability has been discharged over the dam. The width of the impounding pool is from 125 to 200 feet. The dam itself is constructed at a narrow place in the stream and it is anchored against rocks projecting from either side of the ravine, which rocks are in situ, are firm, and afford a strong and solid abutment to support the dam.

In deciding whether a mining operation conducted with this kind of an impounding device should be restrained by the court, I am moved, not so much by consideration of the question of whether or not the mining débris has been successfully impounded by the defendants heretofore as by the probability of its escape from the impounding pool and its consequent injury to the navigability of the lower streams in the future.

The dam in question appears from the evidence to be strong and well built. It is doubtless capable of restraining great pressure. It is a wooden dam, however, and it stands in the bed of a torrential stream. It necessarily follows that it is liable to be carried away by freshets. The same forces that have broken similar dams heretofore are liable at any time to destroy this dam, and if it should be thus destroyed no one can doubt that all the mining débris now impounded above the dam would by the same destructive force be carried into the stream below. Canyon Creek empties into the north fork of the Yuba River, about a mile below the dam. The north fork of the Yuba discharges its waters into the main Yuba, thence into the Feather River, thence into the Sacramento. The evidence would indicate that the impounding reservoir is not full, but that its capacity, while considerably reduced at present may be increased by raising the dam to a height of 100 feet or more.

It is evident that with the increased height of the dam a corresponding increase in its length must be made, thereby entailing a corresponding increase of the danger of its breaking. In view of the principles announced in the decision of this court in the mining débris cases in 1884 (9 Sawyer, 441), and in view of the justly grounded apprehension of injury to navigation in the cases of any wooden dam constructed across the channel of a mountain stream, as in the cases now before the court, I am of the opinion that an injunction should issue as prayed for in the bill.

APPENDIX D.

THE CALIFORNIA DÉBRIS COMMISSION.

AN ACT to provide for the appointment, duties, and compensation of a débris commissioner, and to make an appropriation to be expended under his direction in the discharge of his duties as such commissioner.

The people of the State of California, represented in senate and assembly, do enact as follows:

SECTION 1. The governor of the State of California shall, on or before the first day of January, eighteen hundred and ninety-four, appoint a competent civil engineer for a period of four years only, to be known as and called the débris commissioner.

SEC. 2. Said commissioner shall, during the time he shall be actually employed in the discharge of his official duties, receive a compensation of three hundred dollars per month and his necessary traveling expenses, to be allowed by the State board of examiners.

SEC. 3. Whenever any board of engineers of the United States Government shall have been appointed, with power to adopt plans and specifications for the construction of works for the impounding of mining débris, it shall be the duty of said débris commissioner to consult and advise with such board of engineers of the United States Government, and to examine and pass upon the merits of such works, and said débris commissioner shall determine whether or not such works are calculated to and sufficient to protect the navigable waters of the State, and to keep a record of such determinations.

SEC. 4. There is hereby appropriated, out of the general fund of the treasury of this State not otherwise appropriated, the sum of two hundred and fifty thousand dollars, no warrant against said sum to be drawn or paid until the United States Government shall have appropriated at least an equal amount, to be used in the construction of works for the restraining or impounding of mining débris in California, said moneys to be paid only upon orders drawn by the controller, upon the written request of the said débris commissioner, and to be drawn only for the payment of not more than one-half of the cost of the construction of any such works for restraining and impounding mining débris as shall have been approved by him and duly adopted and recommended by engineers of the United States Government appointed for that purpose.

SEC. 5. The term of office of said débris commissioner shall be four years from the date of his appointment. He shall take the same oath of office as is provided by law for other State officers, and before entering upon the discharge of his duties shall give bond with sufficient sureties, to be approved by the governor of the State, in the sum of fifty thousand dollars, for the faithful discharge of his duties as such officer.

SEC. 6. The said débris commissioner shall have the power to appoint a secretary, at a monthly salary to be fixed by said commissioner, not exceeding one hundred and twenty-five dollars per month; said secretary to hold office at the pleasure of the said commissioner. *Provided, however,* That no secretary shall be appointed until said débris commissioner shall enter upon the actual discharge of his duties.

SEC. 7. All expenditures authorized by the provisions of this act shall be subject to the approval of the State board of examiners; and the State controller is hereby authorized to draw his warrant for all expenditures not in excess of the appropriation herein provided for, so approved by the State board of examiners, and the State treasurer is hereby directed to pay the same.

APPENDIX E.

AN ACT to create the California Débris Commission and regulate hydraulic mining in the State of California.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That a commission is hereby created, to be known as the California Débris Commission, consisting of three members. The President of the United States shall, by and with the advice and consent of the Senate, appoint the commission from officers of the Corps of Engineers, United States Army. Vacancies occurring therein shall be filled in like manner. It shall have the authority and exercise the powers herinafter set forth, under the supervision of the Chief of Engineers and direction of the Secretary of War.

SEC. 2. That said commission shall organize within thirty days after its appointment, by the selection of such officers as may be required in the performance of its duties, the same to be selected from the members thereof. The members of said commission shall receive no greater compensation than is now allowed by law to each, respectively, as an officer of said Corps of Engineers. It shall also adopt rules and regulations, not inconsistent with law, to govern its deliberations and prescribe the method of procedure under the provisions of this act.

SEC. 3. That the jurisdiction of said commission, in so far as the same affects mining carried on by the hydraulic process, shall extend to all such mining in the territory drained by the Sacramento and San Joaquin river systems in the State of California. Hydraulic mining, as defined in section eight hereof, directly or indirectly injuring the navigability of said river systems, carried on in said territory other than as permitted under the provisions of this act, is hereby prohibited and declared unlawful.

SEC. 4. That it shall be the duty of said commission to mature and adopt such plan or plans, from examinations and surveys already made and from such additional examinations and surveys as it may deem necessary, as will improve the navigability of all the rivers comprising said systems, deepen their channels and protect their banks. Such plan or plans shall be matured with a view of making the same effective as against the encroachment of and damage from débris resulting from mining operations, natural erosion, or other causes, with a view of restoring, as near as practicable and the necessities of commerce and navigation demand, the navigability of said rivers to the condition existing in eighteen hundred and sixty, and permitting mining by the hydraulic process, as the term is understood in said State, to be carried on, provided the same can be accomplished without injury to the navigability of said rivers or the lands adjacent thereto.

SEC. 5. That it shall further examine, survey, and determine the utility and practicability, for the purposes hereinafter indicated, of storage sites in the tributaries of said rivers and in the respective branches of said tributaries, or in the plains, basins, sloughs, and tule and swamp lands adjacent to or along the course of said rivers, for the storage of débris or water or as settling reservoirs, with the object of using the same by either or all of these methods to aid in the improvement and protection of said navigable rivers by preventing deposits therein of débris resulting from mining operations, natural erosion, or other causes, or for affording relief thereto in flood time and providing sufficient water to maintain scouring force therein in the summer season; and in connection therewith to investigate such hydraulic and other mines as are now or may have been worked by methods intended

to restrain the débris and material moved in operating such mines by impounding dams, settling reservoirs, or otherwise, and in general to make such study of and researches in the hydraulic mining industry as science, experience, and engineering skill may suggest as practicable and useful in devising a method or methods whereby such mining may be carried on as aforesaid.

SEC. 6. That the said commission shall from time to time note the conditions of the navigable channels of said river systems, by cross-section surveys or otherwise, in order to ascertain the effect therein of such hydraulic mining operations as may be permitted by its orders and such as is caused by erosion, natural or otherwise.

SEC. 7. That said commission shall submit to the Chief of Engineers, for the information of the Secretary of War, on or before the fifteenth day of November of each year, a report of its labors and transactions, with plans for the construction, completion and preservation of the public works outlined in this act, together with estimates of the cost thereof, stating what amounts can be profitably expended thereon each year. The Secretary of War shall thereupon submit same to Congress on or before the meeting thereof.

SEC. 8. That for the purposes of this act "hydraulic mining" and "mining by the hydraulic process," are hereby declared to have the meaning and application given to said terms in said State.

SEC. 9. That the individual proprietor or proprietors, or in case of a corporation its manager or agent appointed for that purpose, owning mining ground in the territory in the State of California mentioned in section three hereof, which it is desired to work by the hydraulic process, must file with said commission a verified petition, setting forth such facts as will comply with law and rules prescribed by said commission.

SEC. 10. That said petition shall be accompanied by an instrument duly executed and acknowledged, as required by the law of the said State, whereby the owner or owners of such mine or mines surrender to the United States the right and privilege to regulate by law, as provided in this act, or any law that may hereafter be enacted, or by such rules and regulations as may be prescribed by virtue thereof, the manner and method in which the débris resulting from the working of said mine or mines shall be restrained, and what amount shall be produced therefrom; it being understood that the surrender aforesaid shall not be construed as in any way affecting the right of such owner or owners to operate said mine or mines by any other process or method now in use in said State: *Provided,* That they shall not interfere with the navigability of the aforesaid rivers.

SEC. 11. That the owners of several mining claims situated so as to require a common dumping ground or dam or other restraining works for the débris issuing therefrom in one or more sites may file a joint petition setting forth such facts in addition to the requirements of section nine hereof; and where the owner of a hydraulic mine or owners of several such mines have and use common dumping sites for impounding débris or as settling reservoirs, which sites are located below the mine of an applicant not entitled to use same, such fact shall also be stated in said petition. Thereupon the same proceedings shall be had as provided for herein.

SEC. 12. A notice specifying briefly the contents of said petition and fixing a time previous to which all proofs are to be submitted shall be published by said commission in some newspaper or newspapers of general circulation in the communities interested in the matters set forth therein. If published in a daily paper, such publication shall continue for at least ten days; if in a weekly paper, in at least three issues of the same. Pending publication thereof said commission, or a committee thereof, shall examine the mine and premises described in such petition. On or before the time so fixed all parties interested, either as petitioners or contestants, whether miners or agriculturalists, may file affidavits, plans, and maps in support of their respective claims. Further hearings, upon notice to all parties of record, may be granted by the commission when necessary.

SEC. 13. That in case a majority of the members of said commission, within thirty days after the time so fixed, concur in a decision in favor of the petitioner or petitioners, the said commission shall thereupon make an order directing the methods and specifying in detail the manner in which operations shall proceed in such mine or mines; what restraining or impounding works, if facilities therefor can be found, shall be built and maintained; how and of what material; where to be located; and in general set forth such further requirements and safeguards as will protect the public interests and prevent injury to the said navigable rivers, and the lands adjacent thereto; with such further conditions and limitations as will observe all the provisions of this act in relation to the working thereof and the payment of taxes on the gross proceeds of the same: *Provided,* That all expense incurred in complying with said order shall be borne by the owner or owners of such mine or mines.

SEC. 14. That such petitioner or petitioners must within a reasonable time present plans and specifications of all works required to be built in pursuance of said order

for examination, correction, and approval by said commission; and thereupon work may immediately commence thereon under the supervision of said commission or representative thereof attached thereto from said Corps of Engineers, who shall inspect same from time to time. Upon completion thereof, if found in every respect to meet the requirements of the said order and said approved plans and specifications, permission shall thereupon be granted to the owner or owners of such mine or mines to commence mining operations, subject to the conditions of said order and the provisions of this act.

SEC. 15. That no permission granted to a mine owner or owners under this act shall take effect so far as regards the working of a mine, until all impounding dams or other restraining works, if any are prescribed by the order granting such permission, have been completed and until the impounding dams or other restraining works or settling reservoirs provided by said commission have reached such a stage as, in the opinion of said commission, it is safe to use the same: *Provided, however*, That if said commission shall be of the opinion that the restraining and other works already constructed at the mine or mines shall be sufficient to protect the navigable rivers of said systems and the work of said commission, then the owner or owners of such mine or mines may be permitted to commence operations.

SEC. 16. That in case the joint petition referred to in section eleven hereof is granted, the commission shall fix the respective amounts to be paid by each owner of such mines toward providing and building necessary impounding dams or other restraining works. In the event of a petition being filed after the entry of such order, or in case the impounding dam or dams or other restraining works have already been constructed and accepted by said commission, the commission shall fix such amount as may be reasonable for the privilege of dumping therein, which amount shall be divided between the original owners of such impounding dams or other restraining works in proportion to the amount respectively paid by each party owning the same. The expense of maintaining and protecting such joint dam or works shall be divided among mine owners using the same in such proportion as the commission shall determine. In all cases where it is practicable restraining and impounding works are to be provided, constructed, and maintained by mine owners near or below the mine or mines before reaching the main tributaries of said navigable waters.

SEC. 17. That at no time shall any more débris be permitted to be washed away from any hydraulic mine or mines situated on the tributaries of said rivers and the respective branches of each, worked under the provisions of this act, than can be impounded within the restraining works erected.

SEC. 18. That the said commission may at any time, when the condition of the navigable rivers or when the capacities of all impounding and settling facilities erected by mine owners or such as may be provided by Government authority require same, modify the order granting the privilege to mine by the hydraulic-mining process so as to reduce amount thereof to meet the capacities of the facilities then in use, or if actually required in order to protect the navigable rivers from damage, may revoke same until the further notice of the commission.

SEC. 19. That an intentional violation on the part of a mine owner or owners, company, or corporation, or the agents or employés of either, of the conditions of the order granted pursuant to section thirteen, or such modifications thereof as may have been made by said commission, shall work a forfeiture of the privileges thereby conferred, and upon notice being served by the order of said commission upon said owners or owners, company, or corporation, or agent in charge, work shall immediately cease. Said commission shall take necessary steps to enforce its orders in case of the failure, neglect, or refusal of such owner or owners, company, or corporation, or agents thereof, to comply therewith, or in the event of any person or persons, company, or corporation working by said process in said territory contrary to law.

SEC. 20. That said commission, or a committee therefrom, or officer of said corps assigned to duty under its orders, shall, whenever deemed necessary, visit said territory and all mines operating under the provisions of this act. A report of such examination shall be placed on file.

SEC. 21. That the said commission is hereby granted the right to use any of the public lands of the United States, or any rock, stone, timber, trees, brush, or material thereon or therein, for any of the purposes of this act; that the Secretary of the Interior is hereby authorized and requested, after a notice has been filed with the Commissioner of the General Land Office by said Commission, setting forth what public lands are required by it under the authority of this section, that such land or lands shall be withdrawn from sale and entry under the laws of the United States.

SEC. 22. That any person or persons who willfully or maliciously injure, damage, or destroy, or attempt to injure, damage, or destroy, any dam or other work erected under the provisions of this act for restraining, impounding, or settling purposes, or for use in connection therewith, shall be guilty of a misdemeanor, and upon con-

viction thereof shall be fined not to exceed the sum of five thousand dollars or be imprisoned not to exceed five years, or by both such fine and imprisonment, in the discretion of the court. And any person or persons, company or corporation, their agents or employés, who shall mine by the hydraulic process directly or indirectly injuring the navigable waters of the United States, in violation of the provisions of this act shall be guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine not exceeding five thousand dollars, or by imprisonment not exceeding one year, or by both such fine and imprisonment, in the discretion of the court: *Provided*, That this section shall take effect on the first day of May, eighteen hundred and ninety-three.

SEC. 23. That upon the construction by the said Commission of dams or other works for the detention of débris from hydraulic mines and the issuing of the order provided for by this act to any individual, company, or corporation to work any mine or mines by hydraulic process, the individual, company, or corporation operating thereunder working any mine or mines by hydraulic process, the débris from which flows into or is in whole or in part restrained by such dams or other works erected by said Commission, shall pay a tax of three per centum on the gross proceeds of his, their, or its mine so worked, which tax of three per centum shall be ascertained and paid in accordance with regulations to be adopted by the Secretary of the Treasury, and the Treasurer of the United States is hereby authorized to receive the same. All sums of money paid into the Treasury under this section shall be set apart and credited to a fund to be known as the "débris fund," and shall be expended by said Commission under the supervision of the Chief of Engineers and direction of the Secretary of War, in addition to the appropriations made by law in the construction and maintenance of such restraining works and settling reservoirs as may be proper and necessary: *Provided*, That said Commission is hereby authorized to receive and pay into the Treasury from the owner or owners of mines worked by the hydraulic process, to whom permission may have been granted so to work under the provisions hereof, such money advances as may be offered to aid in the construction of such impounding dams or other restraining works, or settling reservoirs, or sites therefor, as may be deemed necessary by said Commission to protect the navigable channels of said river systems, on condition that all moneys so advanced shall be refunded as the said tax is paid into the said débris fund: *And provided further*, That in no event shall the Government of the United States be held liable to refund same except as directed by this section.

SEC. 24. That for the purpose of securing harmony of action and economy in expenditures in the work to be done by the United States and the State of California, respectively, the former in its plans for the improvement and protection of the navigable streams and to prevent the depositing of mining débris or other materials within the same, and the latter in its plans authorized by law for the reclamation, drainage, and protection of its lands, or relating to the working of hydraulic mines, the said commission is empowered to consult thereon with a commission of engineers of said State, if authorized by said State for said purpose, the result of such conference to be reported to the Chief of Engineers of the United States Army, and, if by him approved, shall be followed by said Commission.

SEC. 25. That said Commission, in order that such material as is now or may hereafter be lodged in the tributaries of the Sacramento and San Joaquin river systems, resulting from mining operations, natural erosion, or other causes, shall be prevented from injuring the said navigable rivers or such of the tributaries of either as may be navigable, and the land adjacent thereto, is hereby directed and empowered, when appropriations are made therefor by law, or sufficient money is deposited for that purpose in said débris fund, to build at such points above the head of navigation in said rivers and on the main tributaries thereof, or branches of such tributaries, or at any place adjacent to the same, which, in the judgment of said Commission, will effect said object (the same to be of such material as will insure safety and permanency), such restraining or impounding dams and settling reservoirs, with such canals, locks or other works adapted and required to complete same. The recommendations contained in Executive Document Numbered Two hundred and sixty-seven, Fifty-first Congress, second session, and Executive Document Numbered Ninety-eight, Forty-seventh Congress, first session, as far as they refer to impounding dams or other restraining works, are hereby adopted, and the same are directed to be made the basis of operations. The sum of fifteen thousand dollars is hereby appropriated, from moneys in the Treasury not otherwise appropriated, to be immediately available to defray the expenses of said Commission.

Approved March 1, 1893.

APPENDIX A A A.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS.

[Reported under section 2, river and harbor act of 1884, and section 4, river and harbor act of 1886.]

1. Report of Col. Wm. P. Craighill, Corps of Engineers.
2. Report of Capt. O. M. Carter, Corps of Engineers.
3. Report of Col. O. M. Poe, Corps of Engineers.
4. Report of Capt. T. W. Symons, Corps of Engineers.

(1) REPORT OF COL. WM. P. CRAIGHILL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., July 3, 1894.

GENERAL: In compliance with the requirements of General Orders 6 and 7, series of 1887, and 9 of 1888, from headquarters Corps of Engineers, I have the honor to report, concerning the rivers and harbors in my charge, that no additional information on the subject of those orders has been received by me since the last annual report, except as shown by the following statements:

Unknown persons removed pieces of the wales from some of the wing dams on the James River, probably for firewood.

On the Great Kanawha River there has been more or less trouble at the movable dams with drift from booms and from cutting brush, etc., on the banks, but there appear to have been no material or flagrant violations of the law in this respect. The sawmills, so far as this office is informed, have either been burning their slabs, sawdust, etc., or putting it where it is not liable to be washed into the streams. The Winifrede Coal Company and some parties at Charleston (the latter were not thoroughly identified) made some trouble at one time during the year by throwing heavy refuse in the river when repairing boats and barges. This was promptly stopped when notification was given about it.

In regard to the old mill dams on Elk River, no legal action has been taken toward their removal. Gen. C. C. Watts, district attorney for the State of West Virginia, has lately stated that while it is thought an indictment against the owners of these dams could not be maintained, he is of the opinion that the United States has the right to summarily remove the dams as obstructions to navigation. He also said that in a recent conversation with the Attorney-General at Washington the latter expressed himself as of the same opinion in regard to the power of the Government to remove these old dams. General Watts intends to write to the Attorney-General soon to ask for a formal opinion in regard to the matter.

Complaints about these dams continue. Three letters from prominent lumber men on Elk have been received recently complaining about the serious obstruction to the running of rafts and bateaux made by

these dams—particular stress being laid on the Frametown dam and Ashleys dam.

The Elk Island boom at Sutton continues to be the cause of complaint on the part of sawmill men at Charleston, as before reported. (Report of Chief of Engineers for 1892, pp. 3343, 3344.) So far as this office is informed, no legal action has been taken against the company on account of this boom during the year. This same company has built a temporary dam about 8 feet high clear across the river just below the boom for the purpose of floating logs out of the boom. This temporary dam is the cause of considerable complaint on the part of flatboat men, etc., who are obliged to transfer around it in going to and from Sutton with produce and merchandise. The Elk Island Boom Company was indicted by the grand jury of Braxton County at the last April term on account of such complaint about this temporary dam.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

---

(2) REPORT OF CAPT. O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 30, 1894.

GENERAL: I have the honor to report that "no structures or works built or made by the United States in aid of commerce or navigation" within the district under my charge "have been used, occupied or injured by a corporation or individual" during the year, with the following exceptions:

1. The cluster of fender piles and about two pile bents of Dam No. 4, and one of the clusters of fender piles at the end of Dam No. 6, Darien Harbor, Georgia, have been destroyed by an unknown vessel.

2. About 35 feet of the outer end of Jones Island Spur Dam No. 26, Savannah Harbor, Georgia, was destroyed by the British vessel *Edenmore.* This was reported to the United States district attorney, as required by law, but no action was taken by him.

3. About 24 feet of the outer end of Elba Island Spur Dam No. 7 (including one cluster of piles), Savannah Harbor, Georgia, was destroyed by an unknown vessel.

4. About 70 feet of Barnwell Island Spur Dam No. 3, Savannah Harbor, was destroyed by the British steamship *Cynthiana.*

Some minor injuries to pile training walls have been caused by unknown parties, and small quantities of stone have been removed from the dams at Big Gap and Philbrick Cut, Savannah Harbor, Georgia.

Respectfully submitted.

O. M. CARTER,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

---

(3) REPORT OF COL. O. M. POE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 10, 1894.

GENERAL: In accordance with section 4 of the river and harbor act of August 5, 1886, and General Orders No. 9, Headquarters, Corps of

Engineers, June 26, 1888, I have the honor to report the following cases where "piers, breakwaters, etc.," under my charge "have been used, occupied, or injured by a corporation or individual" during the fiscal year ending June 30, 1894.

LANDS OCCUPIED BY U. S. LIGHT-HOUSE ESTABLISHMENT.

The United States Light-House Establishment occupies as site for light-keeper's dwelling a portion of the St. Marys Falls Canal grounds, 100 feet by 200 feet, extending from the south bank of the canal to Canal street, in the city of Sault Ste. Marie, Mich., and just west of the principal meridian of Michigan, the authority for this occupation being a letter of Secretary of War William C. Endicott, dated March 25, 1885, and being terminable at pleasure of the War Department; also, the extreme end of the northwest pier by a light-house, and a portion of the northwest pier by a range light; authority by act of Congress dated March 3, 1879.

The United States Light-House Establishment also occupies the lower and upper ends of the west pier of the St. Clair Flats Ship-Canal by light-houses; authority by acts of Congress dated July 28, 1866, and March 3, 1871.

OCCUPANCY OF PUBLIC LANDS, ETC., BELONGING TO THE RESERVATION OF ST. MARYS FALLS CANAL, MICHIGAN.

During the fiscal year ending June 30, 1894, the reservation has been occupied, as reported in my Annual Report for 1893, printed on p. 4271 *et seq.*, of the Annual Report of the Chief of Engineers for 1893.

The following new case of occupancy has occurred:

By the Edison Sault Electric Company, widening tail race now in use by company. The authority for this action is a "revocable license" to the Edison Sault Electric Company, granted by acting Secretary of War L. A. Grant, on July 6, 1893.

INJURIES TO PIERS, ETC., OF ST. MARYS FALLS CANAL, MICHIGAN.

On August 3, 1893, the schooner *Moravia* ran into south pier, doing $38.83 damage.

On August 7, 1893, the propeller *Athabasca* ran into lock wall (lock 1881), doing $25.50 damage.

On October 16, 1893, the steamer *Tampa* ran into south pier of canal, doing $17.42 damage.

On May 19, 1894, the steamer *Andaste* ran into pier in front of the movable dam of the canal, doing $89.60 damage.

INJURIES TO PIERS, ETC., OF ST. CLAIR FLATS CANAL, MICHIGAN.

On August 19, 1893, the steamer *Marina* ran into west dike of canal, doing $112.18 damage.

On August 27, 1893, the steamer *C. F. Beilman* ran into east pier of canal, doing $121.38 damage.

Very respectfully, your obedient servant,

O. M. Poe,
Colonel, Corps of Engineers,
Bvt. Brig. General, U. S. A.

Brig. Gen. Thomas L. Casey,
Chief of Engineers, U. S. A.

(4) REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., July 1, 1894.

GENERAL: In compliance with General Order No. 6, 1887, and General Order No. 9, 1888, Headquarters, Corps of Engineers, I have the honor to state that no structure or works built or made by the United States in aid of commerce or navigation in the district under my charge are used or occupied by a corporation or an individual.

During the year the jetty being built by the Government at Coos Bay, Oregon, was injured under the following circumstances: During the summer of 1893, a cigar-shaped raft of piles was constructed in Coos Bay, which it was intended to take to San Francisco. The raft contained 3,500 piles from 60 to 100 feet long, bound together with heavy chains. In attempting to tow this raft out of the bay, it struck on the South Spit, and as the tide was ebbing it could not be gotten off. During the high tide at night it floated off and passed around and grounded against the Government jetty, on the north side thereof. Here it continued for three days striking the jetty tramway with terrific force and beating and breaking it down.

It was finally taken away, but not until damage had been done which cost $700 to repair.

The matter was reported to the United States district attorney for Oregon.

Very respectfully, your obedient servant,

T. W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

APPENDIX B B B.

WASHINGTON AQUEDUCT—INCREASING THE WATER SUPPLY OF WASHINGTON, DISTRICT OF COLUMBIA—ERECTION OF FISHWAYS AT GREAT FALLS.

REPORT OF COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

OFFICE OF THE WASHINGTON AQUEDUCT,
Washington, D. C., July 1, 1894.

GENERAL: I have the honor to transmit herewith report of operations for the following works in my charge for the fiscal year ending June 30, 1894, viz: Washington Aqueduct; increasing the water supply of Washington, D. C.; erection of fishways at Great Falls.

Very respectfully, your obedient servant,

GEORGE H. ELLIOT,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

B B B 1.

WASHINGTON AQUEDUCT.

Appropriations for the Washington Aqueduct are applied to the improvement, the maintenance, and repair of those portions of the Washington water supply, other than the tunnel from the distributing reservoir to the new reservoir near Howard University, that have been placed under the supervision of the Chief of Engineers. The works include the masonry dam, 2,877 feet long, extending from the Maryland to the Virginia shore at Great Falls of the Potomac, 14 miles west of Washington; the works at Great Falls for regulating the supply of the conduit; the conduit from Great Falls, 9 feet in diameter; the three reservoirs, viz, the Dalecarlia receiving reservoir, about 4½ miles west of the city, the distributing reservoir, about 2 miles west of the city, and the high service reservoir in Georgetown for the supply of the higher portions of that city; the mains by which the water is

carried from the reservoirs and delivered into the city's distributing system, and the bridges for supporting the mains across Rock Creek.

The following statement exhibits the condition of the aqueduct and its accessory works, and the operations of the last fiscal year:

THE DAM AND OTHER WORKS AT GREAT FALLS.

Advantage was taken of the very low condition of the Potomac in August to replace the riprap back of the dam that had been carried away by ice in the two preceding winters. Five hundred and one cubic yards were used for this purpose at the dam across the Virginia channel and 405 cubic yards at the dam across the Maryland channel, making a total of 906 cubic yards. This work had been postponed on account of want of funds for the purpose.

A new frame was made for the screen at the intake of the conduit.

The painting of the machinery that operates the valves in the gate house and the roof of the gate house were commenced in June and nearly completed.

On December 21 there was introduced into the Senate of the United States and referred to the Committee on the District of Columbia a bill entitled "A bill to amend an act approved July 15, 1882, entitled 'An act to increase the water supply of the city of Washington and for other purposes.'" The bill provided for the acquirement by the United States by the right of eminent domain or otherwise, of so much of the land and water rights at Great Falls as might be deemed necessary for the present and future water supply of the District of Columbia. It also provided for securing by the United States to its co-owners in the land and water rights at the falls, by contracts, the right to use and the facilities for using the remainder of the flow of the river, and for the ascertainment and payment of damages for the land and water rights taken under the act of 1882.

In the report on the bill which I made on March 20, and of which a copy will be found in Appendix 3, I endeavored to show that while the remainder of flow above mentioned would amount to five-sevenths of the low-water flow and sixty-three sixty-fifths of the average flow, the riparian rights of the United States at Great Falls are so extensive that the Government appears beyond all question to own by far the greater part of all the water flowing at that point; that, therefore, it would be unwise for the United States to enter into the contracts referred to, but that on the contrary it should proceed to acquire by the exercise of the right of eminent domain, or otherwise provided for in the bill, all of the water and water rights at Great Falls not now owned by it, to the end that the United States for itself and the District of Columbia could not only increase from time to time and without limit and without further controversy with its co-owners (the Great Falls Manufacturing Company and the Chesapeake and Ohio Canal Company) the supply for ordinary purposes, but could utilize the remainder for power to be used in the generation of electricity for the lighting of the public buildings, the public grounds and streets of Washington, for the pumping of water to the higher levels of the city, and for other public purposes.*

*A delay in submitting this report enables me to also append hereto (see Appendix 6) a report of a board of engineer officers, dated July 18, 1894, upon the feasibility and advisability of using the water power of the Great Falls of the Potomac or other water power in the neighborhood of Washington, D. C., for the purpose of lighting by electricity the public buildings, grounds, and streets of the District of Columbia.

These suggestions were approved by the committee, and the bill as amended now pending (S. 1359 and H. R. 7280, Fifty-third Congress, second session) provides for legislation that is of the highest importance to the United States and the District of Columbia, and in respect of the water supply of Washington more important than any that has been enacted since the completion of the aqueduct thirty years ago.

It is understood that the property has recently been offered for sale to private parties at the price of $350,000, and I think that there can be no doubt that it can be acquired by the process provided for in the bill at a fair and reasonable price, fair to the United States and the District of Columbia, and fair to the co-owners.

The importance of early action in this matter is stated in the report of the Senate Committee on the District of Columbia in the following terms:

If the entire power at Great Falls is acquired, we believe it will be ample for electric lighting and pumping purposes for the city. The Great Falls Power Company have very recently obtained new charters from the legislatures of Virginia and Maryland. Their purpose is evidently to develop the power and supply it directly, or through other companies, to the city for lighting and other purposes.

There are no improvements now at Great Falls except the Aqueduct dam, built and owned by the United States. If the Government is ever to acquire control it should be done before any outlay is made by the other owners. Such outlay must be to them a questionable investment, in view of the fact that the Government is sure to require an increased supply from time to time in the future, thus endangering the business of the power company and destroying or greatly lessening the value of their improvements, with the risk that they may not be sufficiently recompensed. Your committee are therefore of the opinion that all the water and riparian rights at Great Falls necessary for the control and use of the entire power should be acquired at this time; that it will be a wise economy to do so; that ownership in part by the United States and in part by private business corporations is a relation unwise and unsafe for the Government, and should be terminated at once; that the other owners can afford to surrender their rights now on much better terms for the Government than after they have made their improvements, and that no outlay of money can contribute more than this to the future welfare of the capital of the country.

There is another reason why the bill should be acted upon at the earliest possible moment.

There is immediate necessity for raising the dam at Great Falls, and in my estimates appended to this report will be found an estimate of $125,000 for the work. An explanation of the same will be found under the title "Explanations of estimates."

Not since the 48-inch main was laid have there been so many complaints of want of water as during the present summer, not only in the higher portions of that part of the city supplied by gravity, but in other portions of this area from which complaints have never come before. I am informed that many houses, including some of the better class as far down as Lafayette Square, are losing their tenants because they can not get water in their bathrooms, and it is feared that pecuniary loss, sickness, and inconvenience will result from this state of affairs. The District authorities are extending the area of high service (to which water is pumped from the United States mains) to Tennallytown, Brightwood, and other places in the "county." As this will make a new and increased demand on the mains, it is certain that the deficiency in the portion of the city supplied by gravity will soon be greater than it is now, and the only remedy, other than the stopping of unnecessary and avoidable waste by the enactment of a law requiring the use of meters by all consumers of Potomac water, is the raising of the dam.

When the dam was last raised and extended to the Virginia shore

(the work was finished in 1886), increasing the supply to the city about 25,000,000 gallons per diem, it gave rise to extraordinary claims for damages on the part of the coowners with the United States of the land and water rights at Great Falls, amounting to hundreds of thousands of dollars, which have not been settled to this day. In my judgment but a very small portion of these claims is justly due, but whatever be paid on them will have to be paid jointly by the United States and the District of Columbia.

For the reason, therefore, that the respective amounts of water to which each of the three riparian owners at Great Falls is entitled have never been judicially determined, they should be so determined, or, if it be possible, the United States should acquire all of the water at the Falls in the manner proposed, before another increase in the height of the dam be made.

I should further remark in connection with this subject, that the object of raising the head of water at the in-take of the conduit is to increase the velocity through the conduit, and thus enable it to bring more water down from Great Falls and into the distributing reservoir, to the end that the water in this reservoir may be kept up to its proper height of 146 feet above datum. It may be found, however, that even with the water in the distributing reservoir at this height, it will not restore the pressures in the city (which by reason of the rapid increase in consumption and waste, are constantly falling), to what they were when the 48-inch main, which I laid in 1890, was first put in operation.

In this case, it will be necessary at once to finish the tunnel connecting the distributing reservoir with the new reservoir near Howard University, or to lay another 48-inch main from the distributing reservoir to and through the city. It should be understood, however, that neither of these is the alternative of raising the dam at Great Falls, which must be done in any case, and with the least delay practicable.

Estimates for raising the height of the dam at Great Falls, for the protection of the inlet to the Aqueduct, and for the construction of a storehouse at Great Falls, will be found in the list of estimates appended hereto, and explanations of the same will also be found further on in this report under the title "Explanations of estimates."

THE RESERVOIRS.

A portion of the land required for the improvement of the Dalecarlia receiving reservoir, for which an appropriation of $60,000 was made in the act of Congress of March 3, 1893, was acquired by the purchase of five parcels, the areas and the dates of the deeds of which, as well as the dates of their record, will be found in the following table. The deeds are recorded at Rockville, Md., in the office of the clerk of the circuit court of Montgomery County. Boundary stones have been planted at the corners of these lands.

Grantor.	Area.	Date of deed.	Date of record of deed.
	Sq. ft.		
Ignatius Belt	2,730.72	July 10, 1893	Aug. 30, 1893
James Harper	13,275	...do	Oct. 11, 1893
Wm. Frank Harper	12,744	...do	Do.
Norwood Real Estate Co	219	Nov. 22, 1893	Jan. 18, 1894
Metropolitan Southern R. R. Co., right of way only	1,080.36	Nov. 25, 1893	Do.

One and forty-two one-hundredths acres of land were also obtained by lease from Ignatius Belt, for one year from July 10, 1893, with the privilege of extending the same for one or two years longer, at the option of the United States, for the purpose of constructing thereon the temporary buildings required.

The preparatory work of this improvement, a description and the plans of which were contained in my last annual report, commenced on July 5. A road was graded extending from the Conduit road at the western foot of Dalecarlia Hill to the mouth of the proposed tunnel near waste weir No. 2 of the Washington Aqueduct, to be used for hauling the compressor and other drilling plant and the materials required for the work. A wooden flume 250 feet long, 4 feet wide, and 12 inches high was constructed from the mouth of the tunnel leading from the waste weir to Little Falls Branch, which flume was made necessary by the leakage from the gates in the dam of the waste weir, which ran directly over the site of the portal of the proposed main drainage tunnel. A magazine of rubblestone was constructed in the valley of Little Falls Branch, above the reservoir, for the storage of dynamite. A blacksmith shop, a storehouse, and other necessary buildings were constructed at points convenient to the work, and a building was hauled from the Champlain avenue shaft of the tunnel leading to the new reservoir near Howard University, to serve as the office of the assistant engineer in local charge of the work. A railway about 500 feet long was constructed for the transportation of material, and a telephone line, connected with this office, was run to the work.

For the purpose of guarding the proposed shaft in the valley of Little Falls Branch and the hoisting machinery in floods, a temporary dam was constructed across the branch at a distance of about 100 feet from the site of the shaft, and the channel of the branch was changed from the west to the east side of the valley. Careful surveys were made along the route of the proposed open channels between East and Mill creeks and between the latter and Little Falls Branch, and borings were made on the sites for the permanent dams across these streams.

Contracts were made with the Ingersoll-Sergeant Drill Company, of New York, for furnishing a 40-horse power boiler, an air compressor, and other machinery required for driving machine drills; with McMahan, Porter & Co., of New Cumberland, W. Va., for re-pressed vitrified bricks for the invert, and with the Frederick Brick Works, of Frederick, Md., for common bricks for the main body of the lining of the tunnel and for the shaft; with James H. McGill, of Washington, D. C., for Cumberland hydraulic cement, and with the American Forcite Powder Manufacturing Company, of New York, for dynamite and exploders.

As soon as the water from Waste Weir No. 2 had been turned into the flume and disposed of (July 17), work on the rock excavation of the open cut was commenced with a gang of drillers and laborers. On the 24th another 8-hour shift was put on, and on the 29th the excavation of the open cut was completed by the removal of 538½ cubic yards of rock. Its total length is 70 feet.

On August 1 the excavation of the tunnel was commenced, and from the 3d of that month, when the third shift was put on, until its completion on February 6, it was carried on night and day, except on Sundays and holidays. The excavation, by hand drilling, of the shaft in the valley of Little Falls Branch was commenced on October 12, and was completed to the top of the space to be occupied by a water cushion on January 8. The excavation of the tunnel from its north-

erly end at the bottom of the shaft was then commenced, also by hand drilling, and carried on until February 3, when the heading met the heading of the machine drillers working from the southerly end. The excavation for the tunnel was 11 feet in diameter and for the shaft it was 16½ feet square. A large portion of the rock through which the Tunnel passed was very seamy and liable to slips, the joints being filled with a material resembling mud, and heavy timbering was necessary to prevent accidents.

The route of the drainage tunnel, passing as it does under Aqueduct Tunnel No. 4, through which passes the entire water supply for Washington, especial precautions were taken not to injure the latter tunnel, which is unlined at the point of crossing, by the dynamite blasts in the former. To this end the drill holes were limited to 3½ instead of 6 feet in depth, which was the rule in other parts of the tunnel, and the charges were limited to 1½ pounds of 40 per cent dynamite.

The total number of cubic yards of rock excavation was 3,771, the cost of which, including the cost of labor, dynamite, and materials, but excluding the cost of tools and machinery, was, for the tunnel, $6.20 per cubic yard, and for the shaft $6.87 per cubic yard.

About 9,000 pounds of dynamite were used in the work.

Taking into consideration the size and shape of the tunnel, the dangerous material encountered, and the continually increasing quantity of water that poured through the seams of the rock during the sinking of the shaft, the progress made in this work compares very favorably with works of similar character in other parts of the country.

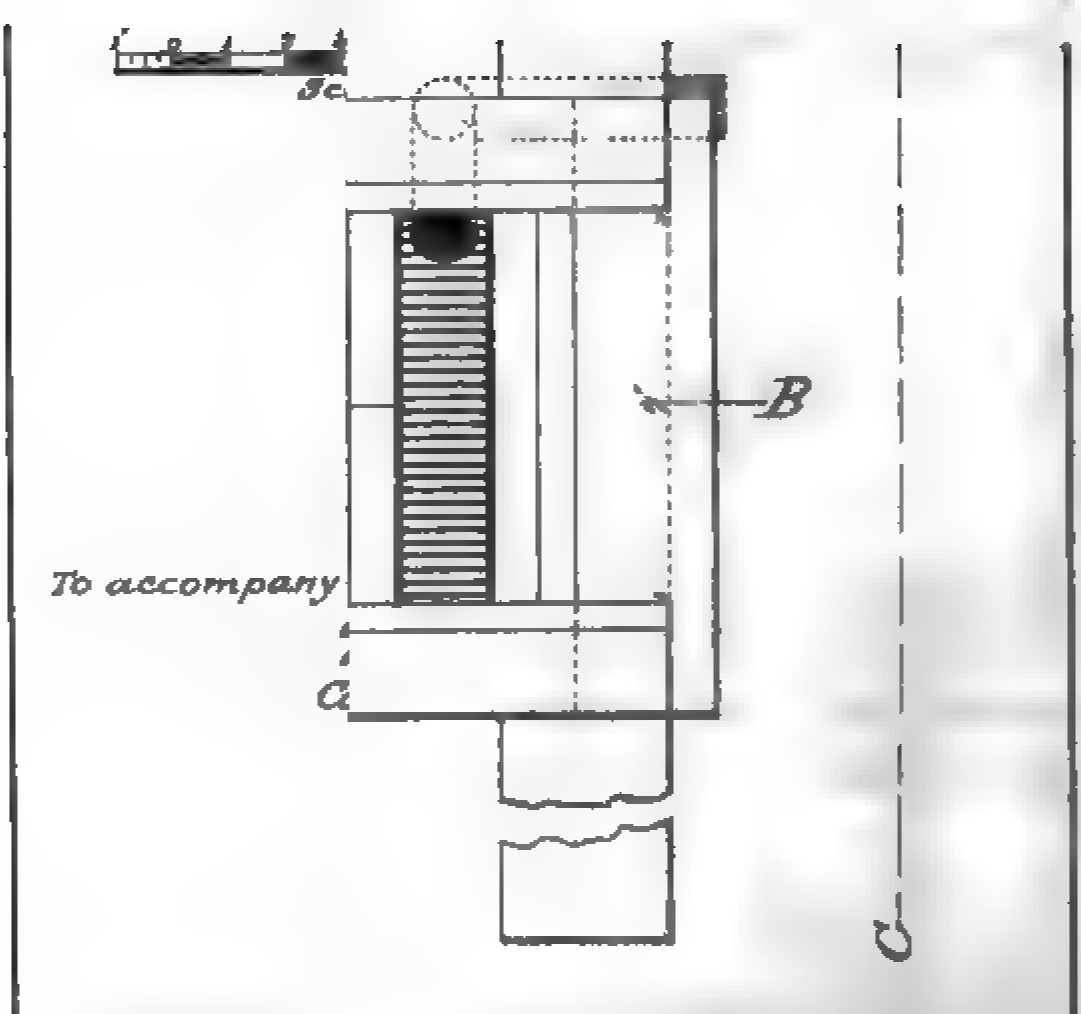
One of the headings was driven a distance of 50 feet in one week, the average weekly distance being 31 feet, and a depth of 8 feet was made in one week in the shaft, the area of the cross section of which was 273 square feet.

After trimming the tunnel for the lining and laying of the concrete foundation for the vitrified brick invert, the brick lining of the tunnel was commenced on the 19th of March. It and the portal wall were completed on June 20. The lining of the shaft, which is 10 feet interior diameter, was completed to the coping on June 19. The arched lining of the tunnel is 7 feet interior diameter, and from the center of the shaft in the valley of Little Falls Branch to the portal on the southerly side of Dalecarlia Hill, its length is 965.6 feet. From the bottom of the invert to a height of 2 feet on the sides, the arch is laid with vitrified brick to take the wear of the gravel and sand that will pass through the tunnel. The depth of the shaft from the surface of the ground to the bottom of the tunnel is 62 feet, and to the bottom of the water cushion it is 70 feet.

For a distance of 10 feet from the shaft the tunnel arch is constructed entirely of vitrified brick, and, as it supports the lining of the shaft, it is, above the springing line, 4 rings thick; for a distance of 165 feet southerly the arch above the vitrified brick invert is 3 rings thick; for a farther distance of 89.5 feet it is 2 rings thick; for a farther distance of 20 feet (this is under Aqueduct Tunnel No. 4) it is 3 rings thick, and thence to the south end of the tunnel it is 2 rings thick. The spaces between the arches of the tunnel and shaft and the rock were packed very carefully and solidly with rubblestone laid in cement mortar.

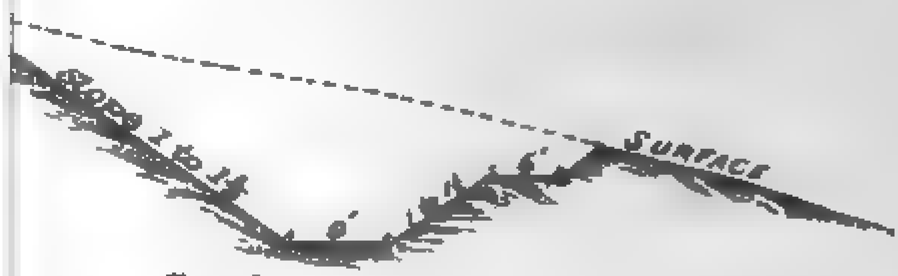
There were used for lining the tunnel and shaft 107,878 vitrified bricks, 231,979 common bricks, and 2,231 barrels of cement.

Much credit is due Mr. F. W. Johnston, my assistant engineer in immediate charge at the work, for zealous and skillful supervision and very correct instrumental work, the center lines run from the two ends of


To accompany
B
C

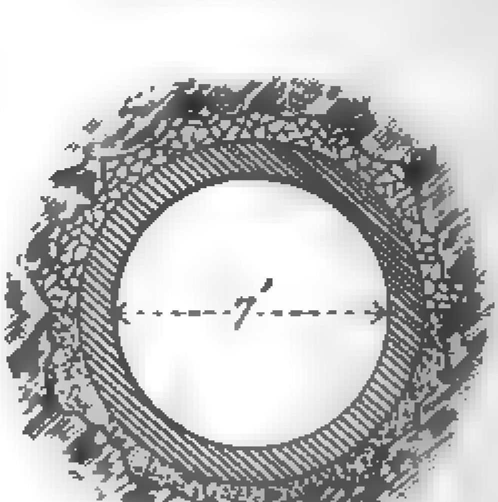
on A,B.

To accompe



Section on A,B.

Section on C,D.



Cross section.

the tunnel meeting within one-fourth of an inch, and the levels for grade as run from the two ends differing by only $\frac{28}{1000}$ of a foot; also to Mr. Peter McAtee, tunnel foreman, for the very efficient performance of his duties.

The oversight of the work, both by Mr. Johnston and Mr. McAtee, was so careful that there was no loss of life, and no man was injured from the beginning to the end of the work. This is a record of the use of high explosives in tunnel work that has rarely, if ever, been equaled.

I am also indebted to Mr. John T. Ensor, U. S. attorney for the district of Maryland, for his prompt, efficient, and zealous assistance in examining and passing upon the titles to the lands that I was required to purchase for the work.

The main drainage tunnel under Dalecarlia Hill and the shaft in the valley of Little Falls Branch, the most important and difficult parts of the project for the improvement of the Dalecarlia receiving reservoir, are now complete except the coping of the shaft and the retaining wall in the side of the hill in rear of the shaft, and the appropriation has been exhausted.

There remains to be done for the completion of the project a short tunnel through the hill on the easterly side of Little Falls Branch; the permanent dams across the valleys of Little Falls Branch, Mill Creek, and East Creek, and the open channels between these streams that are to conduct all the polluted waters of the watershed of the reservoir into Little Falls Branch, from which they will pass into the shaft and thence by the main drainage tunnel around the reservoir and into the Potomac. When this has been done, the water of the reservoir will be drawn off, the reservoir will be filled with Potomac water from Great Falls, and the passage through the reservoir of this water, for which purpose it was originally constructed, will be renewed. The work can be completed in the next fiscal year if the necessary appropriation be made by Congress.

Accompanying this report will be found plats showing the portal of the main drainage tunnel and the shaft in the valley of Little Falls Branch; also the short tunnel through the hill east of Little Falls Branch yet to be excavated.

Respecting the latter, and also the open channels between the tunnel and Mill Creek and between Mill Creek and East Creek, of which a plan was shown in my last annual report, I have to remark as follows:

The greatest quantity of water (see my last annual report) that is likely to pass through this tunnel in the heaviest rainfall, as found by the Burkli-Ziegler formula, $Q = f.\, r\left(\frac{S}{A}\right)^{\frac{1}{4}}$, is 418 cubic feet per second.

If we make the interior diameter of the tunnel 7 feet, which is the diameter of the main drainage tunnel just completed, we can have the economical advantage of being able to use the "centers" constructed for the latter tunnel. The velocity with the tunnel running full would then be 10.86 feet per second. That with this velocity the invert would not be abraded by sand and pebbles carried along by the water, is shown by the fact that in Washington there has not been found any abrasion of inverts of sewers, when made of vitrified brick, from velocities as high even as 16 feet per second.

By the Kutter formula $V = \left(\dfrac{41.6 + \dfrac{1.811}{n} + \dfrac{0.00281}{I}}{1 + \left(41.6 + \dfrac{0.00281}{I}\right) \dfrac{n}{\sqrt{R}}} \right) \sqrt{RI}$, and

assuming 0.013 as the coefficient of the roughness of the brick lining of

the tunnel, I find that the slope required to produce this velocity is 0.0041, or 0.41 of a foot in 100 feet.

The open channel from Mill Creek to the tunnel will have to carry the same quantity of water, viz, 418 cubic feet per second. In determining the slope of this channel I have thought that it would be better to provide for a velocity too great than one too small. If it be too great and erosions of the bed should occur at points where the soil is less resisting, these places can be paved as successively may be found necessary, whereas if it be too small there would be required an annual expenditure from the appropriation for maintenance and repair of the aqueduct for removing deposits from the channel. I therefore propose to provide for a mean velocity of about 4 feet per second. This would be slightly excessive if the channel should run full, but as the calculation of 418 cubic feet per second was under the extreme supposition of a rainfall of 1½ inches per hour over the entire watershed of the reservoir in a storm of several hours duration, and as the highest rate of rainfall recorded at the signal office in Washington between June, 1876, and November, 1892, was only 1.20 inches per hour for one hour, the probabilities are that the channel will never run full.

When it does not run full or nearly full (during the major part of the year there will be but a few inches of water in the channel) the mean velocities will be less and there will be a danger, that can not be avoided in so changeable a stream, of deposits in the channel.

For a mean velocity of 4 feet per second the waterway would require to have a cross section of not less than 104.5 square feet. If the channel be made 6 feet deep and 9 feet wide at bottom, with side slopes of one vertical to one and a half horizontal, its cross section would contain 108 square feet, and by the Kutter formula, assuming 0.03 as the value of n, I find that the slope required to enable this channel to carry 418 cubic feet per second is 0.0012, or say 1.2 feet in 1,000 feet.

I therefore propose for the tunnel an interior diameter of 7 feet and a slope of 0.0041; to make the open channel between Mill Creek and the tunnel 6 feet deep and 9 feet wide at bottom with the side slopes just mentioned, and that the channel shall have a slope of 0.0012.

Under the same supposition of 1½ inches per hour rainfall, the channel from East Creek to Mill Creek will have to carry (see also my last annual report) 110 cubic feet of water per second. For a mean velocity of 4 feet per second the cross section of the channel must therefore have an area of not less than 27½ square feet. A channel 3 feet deep and 5 feet wide at bottom with the same side slopes as before would have an area of 28½ square feet. The proper slope or inclination in this case would be 0.003, or 3 feet in 1,000 feet, and I propose to make the channel accordingly.

Estimates for completion of the works of improvement of the Dalecarlia receiving reservoir and purchase of land authorized by the act of March 3, 1893, for lowering the height of the cross dam at the distributing reservoir, and for cleaning out the distributing reservoir, will be found in the list of estimates appended hereto, and explanations of the same will be found further on in this report under the title "Explanations of estimates."

THE CONDUIT AND THE CONDUIT ROAD.

For want of funds nothing has been done during the last fiscal year in the work of removal of deposits in the conduit, which my inspection of its interior in September, 1891, found to amount to about 15,000 cubic

yards. The deposits interfere with the full flow of the conduit, and, with the want of height of the dam at Great Falls, although not to so great a degree as the latter, they are a cause of a deficiency of water in the distributing reservoir, which in turn give rise in summer to complaints to the District Commissioners from householders in the city. Their removal requires the emptying of the conduit throughout its length and the digging up and loosening of the deposits and sluicing them out through the waste gates and valves in the conduit, and is very expensive by reason of the necessity of employment of night labor, which costs more than day labor, and by reason, also, of its frequent interruptions during the refillings of the distributing reservoir required to keep up the supply of the city. The work can not be done by means of the small annual appropriations for repairs of the aqueduct, and in my estimates of 1892, and again in 1893, I asked for an appropriation of $14,000 for this purpose, but it has not yet been granted by Congress.

It is a most important work, and I again include the item in my annual estimates.

The deposits in the 7-foot by-conduit at the distributing reservoir were removed in July. There was a depth of about 2 feet at the influent gatehouse, and it decreased to about 6 inches at the auxiliary gatehouse.

The trouble heretofore had in opening the waste gate in the dam of wasteweir No. 3 was ended by the making of an iron ratchet for maneuvering the gate.

Seven hundred and eighty-four cubic yards of flint rock, purchased in February, were crushed in April and piled on the side of the Conduit road above the distributing reservoir, for use in the repair of the road from this reservoir to culvert No. 24 during the next winter. The stone cost 93 and 95 cents and $1 per cubic yard, and the cost of setting up the steam crusher, crushing the stone, and piling it was 41 cents per cubic yard.

Sixteen boundary stones were planted between Cabin John bridge and Griffiths Park bridge (bridge No. 3), and six were planted between the distributing reservoir and the Dalecarlia receiving reservoir.

The Conduit road, from the intersection of the Foxhall road to the upper end of the distributing reservoir, was repaired in February with 1,088 cubic yards of crushed bluestone, from the quarries on the Virginia side of the Potomac, instead of the white flint rock heretofore used on this road. The distance is about 5,000 feet, or about 1 mile. The stone was put on about 4 inches deep, and it was thoroughly rolled with the 15-ton steam roller kindly loaned me by the District government. I was induced to use bluestone for this repair of the road by the exorbitant demands of the owners of flint rock in the vicinity as to prices and by an experiment I made respecting the comparative resistance to abrasion of bluestone and flint rock. This was made at a foundry in a large cylinder termed a "rumbler," used for cleaning castings. The cylinder, partially filled with 300 pounds of broken stone and 100 pounds of broken iron castings, was revolved at the rate of 30 revolutions a minute, the fine material as fast as it was worn from the stone falling out through interstices in the cylinder. The loss of weight of the bluestone by this process was found to be considerably less than from the flint rock, but experience has since proved that the latter makes by far the better pavement. It is not so dusty in summer or muddy in winter, and this is doubtless due to the fact that the particles worn from the flint rock are in the form of sand, while those

from the bluestone make a fine powder. This trial of the relative values of bluestone and flint rock for macadam was conclusive, and I will use no more of the former for repairs of the Conduit road.

The only hill on the Conduit road this side of the hills near Great Falls is Dalecarlia Hill, near the upper reservoir. It had for several years been in a bad condition, especially on its western side, and it was very thoroughly repaired in December by covering it with a macadam pavement over a length of about 650 feet. About 500 cubic yards of flint rock were used in the work.

Estimates for the removal of deposits in the conduit, for raising the masonry casings of the manholes along the line of the conduit, and for commencing the work of widening the macadam pavement of the Conduit road by widening the pavement of the road between the two reservoirs, will be found in the list of estimates appended hereto, and explanations of the same will be found farther on in this report under the title "Explanations of estimates."

THE MAINS.

The trunk mains that lead from the distributing reservoir and supply the distributing system of street mains were laid by the United States, and are under the care of this office. The aggregate length of these mains is about 21 miles. The distributing mains were laid by the District of Columbia and are under the care of the Commissioners of the District.

There have been no breaks in the United States mains during the last fiscal year, and the only labor expended upon them has been in the driving up of the lead in a few of the joints where it was found necessary, and in providing against the bursting in freezing weather of the small valves designed for admitting air while emptying the 48-inch and 30-inch mains that were laid under the provisions of the act of March 2, 1889. These valves are at the following places: 2 valves at Thirty-fourth and M streets, 2 valves at Thirty-second and M streets, 2 valves at Twenty-fourth and M streets, 2 valves north of Dupont Circle, 2 valves at Fourteenth and R streets, 1 valve at Third and East Capitol streets.

Our experience in the winter of 1892-'93, when the frost penetrated the ground to a depth of 4 feet, showed the necessity of this precaution.

The lines of the trunk mains have been carefully inspected and flushed monthly, and the valves have been regularly oiled and cleaned during the year.

An estimate for inserting efficient air valves and blow-off valves in the old 30-inch and 36-inch mains will be found in the list of estimates, and explanations of the same will be found farther on in this report under the title "Explanations of estimates."

THE AQUEDUCT LANDS.

I have been unable during the year to extend the surveys of the aqueduct lands beyond Griffiths Park bridge, or bridge No. 3, but it is my intention to recommence these surveys early in the next fiscal year and to carry them as far toward Great Falls as other necessary work and the funds available will allow.

On April 25 notices were served, by direction of the Secretary of War, on the owners of encroachments on the aqueduct lands developed

by previous surveys, to terminate these encroachments within specified times and under specified penalties, as follows: Heirs of the late Mrs. R. Bobinger, E. & E. Baltzley, Ignatius Belt, Benjamin Newman, Thomas Tuohy.

On the application of the first of these encroaching owners, the Secretary of War granted on May 7, 1894, a revocable license to William Bobinger to occupy so much of the land of the United States as is covered by the Cabin John bridge hotel, under the conditions that early steps be taken by the owner to secure the passage by Congress of an act to authorize the sale of the land so occupied, and that if he shall fail to acquire title to said land by April 25, 1895, he shall terminate his encroachment within three months of the said date. If the encroachment be not terminated within said period, the removal of the encroachment may be effected by the United States at the expense of the owners without any right to damages by him on account thereof, and any sum that may be expended by the United States for this purpose shall be repaid by the owner on demand. A bill (S. 2118 and H. R. 7502) has been introduced at the current session to authorize the Secretary of War to sell the land in question, and the bill is now pending.

THE BRIDGES.

The wrought-iron riveted girder bridge north of the M street highway bridge, which carries the 48-inch main across Rock Creek, was thoroughly tightened up, and it and the Pennsylvania avenue aqueduct bridge were painted. Both of the bridges are in excellent condition.

The pavements of Griffiths Park bridge (bridge No. 3) and Cabin John bridge (bridge No. 4) remain in the same condition as previously reported, but it is expected that an appropriation will be made at this session of Congress for the repavement of these bridges, there being an item of $5,000 for this purpose in the District bill as it has passed the House of Representatives.

Estimate for replacing the wooden bridge over the spillway at the Dalecarlia receiving reservoir by a stone structure, commensurate in durability and appearance with the other bridges on the line of the aqueduct, will be found in the list of estimates appended hereto, and explanations of the same will be found farther on in this report under the title "Explanations of estimates."

FILTRATION.

Every year, mainly in the latter part of winter, when heavy rains falling on the watershed of the Potomac and its tributaries, especially the Shenandoah, have found the ground loosened up by alternate thawing and freezing, there are complaints in the press and elsewhere of the turbidity of the Potomac water, and the same is true in the spring when the fields are plowed. They are not very urgent or very prolonged, for the water soon clears; but as they are sometimes accompanied by demands for the filtration of the water, it may be well in this, my last annual report before retirement from active service, to describe in a general way the two systems of filtration now in use, and to state what would be approximately the cost of each if applied to the water furnished to the District of Columbia.

I should first remark that it seems to be commonly believed that, although our Potomac water is often so offensive to the eye as to make

it appear to be unfit even for bathing purposes, it does not contain germs of disease and is not unhealthful. I think this belief is well founded.

Dr. Busey, president of the Medical Society of the District of Columbia, in an address before the Appropriation Committee of the House of Representatives on June 14 last, urging an appropriation for improving the sewerage of the city, stated that no germs of typhoid fever (one of the most dreaded of all disease germs) have been found in Potomac River water; and Dr. Wales, recently director in charge of the Museum of Hygiene of the Navy Department, at which daily analyses of the water have been made for some years, in a communication to this office giving the results of a chemical examination of Potomac water when it was in a turbid condition,* stated that although there are found in Potomac water five forms of micro-organisms, they are all innocuous and are generally present in all river waters, and added that he regarded this water, "after a careful study for three years bacteriologically, as good as any river water in the world."

That the Potomac water should compare favorably with the best river waters might be inferred from the character of that part of its watershed that is above Great Falls. From the source of its north branch, in western Maryland, about 200 miles above Great Falls, following the course of the stream; from the source of the south branch in West Virginia, about the same distance, and from the source of its principal tributary, the Shenandoah, about 175 miles above the falls, the country is mostly wooded and mountainous. There are but a few large towns on these streams, and I understand that none of them are sewered.

The following table gives the names of the principal towns above Great Falls on the Potomac and its tributaries, with their population and distances above the falls, stated approximately:

Towns.	Distances above Great Falls.	Population.
	Miles.	
Harpers Ferry, W. Va	44	958
Shepherdstown, W. Va	54	1,615
Charlestown, W. Va	54	2,016
Williamsport, Md	75	1,277
Front Royal, Va	84	829
Hancock, Md	84	815
Cumberland, Md	127	12,729
Keyser, W. Va	147	1,693
Piedmont, W. Va	152	1,853

The foregoing table, when considered in connection with the well-established fact that rivers, especially those that flow over rocks and dams and those that have wide surfaces exposed to the sun and air, tend to purify themselves, gives assurance that under ordinary conditions we have little to fear from our Potomac water.

As an example of the self-purification of rivers, I may mention the river Limmat in Switzerland, which, receiving at its upper end the

*[Expressed in parts per million.]

Color	Yellowish.	Free ammonia	0.016
Odor	None.	Albuminoid ammonia	0.160
Turbidity	Considerable.	Nitrites (as nitrogen)	None.
Sediment	Slight.	Nitrates (as nitrogen)	1.12
Residue on evaporation	169	Chlorine	0.981
Loss in ignition	97	Hardness	53
Fixed solids	72		

pure water of Lake Zurich, found by analysis to be purer than spring water, is polluted about 2 miles below the lake by the sewage of Zurich, a city of about 93,000 inhabitants. This sewage amounts to about 0.2 per cent of the total flow of the river, and it contaminates the river to such a degree that nearly a million bacteria, in their various forms, per cubic centimeter (a centimeter is about two-fifths of an inch), are sometimes found in the water just below the outflow of the sewage into the river.

In 1889 a series of weekly bacteriological investigations, extending from January to April (see Appendix 4), was very carefully made by the Hygienic Institute of Zurich to determine from samples of water, taken from the river at measured intervals below the outfall of the sewage, whether the sewage rendered the water below Zurich unfit for domestic purposes and for pisciculture.

It was found that at the point where the sewage enters the river the water of the river contained on an average 296,670 bacteria to the cubic centimeter; that at a point about one-third of a mile below the number of bacteria had decreased to an average of 12,870 per cubic centimeter, a decrease of 96 per cent; that of this number there was found at a point about one-third of a mile further down the river 10,892 bacteria per cubic centimeter, a decrease of 15 per cent; that of this number there was found at a point about five-eighths of a mile still further down 5,902 bacteria per cubic centimeter, a decrease of 46 per cent; and so on down the river to a point where the water was found to be as pure as at its issue from the lake, and the conclusion was reached that "under the conditions described, and provided there are no intermediate sources of pollution, a river such as the Limmat, flowing at a mean velocity of about 4 miles per hour, will purify itself within a distance of about 16 miles from the point of pollution." Details of the very full and complete experiments at Zurich will be found in Appendix 4. The entire paper from which they have been taken, which contains in addition very interesting accounts of the thorough system of bacteriological and chemical examinations of the Limmat water, and of the new filtration works of that city, may be found in the Proceedings of the Institution (British) of Civil Engineers, Vol. CXI, 1892–'93, Part 1. The experiments on the water of the Limmat seem to be conclusive in respect of that river, but they should not lead to the taking for domestic purposes of the water of any other river polluted by the drainage from a sewered town, except at such a distance below the point of pollution that there can be no question as to the quality of the water.

It will be seen from the foregoing table that the first town above Great Falls is the small town of Harpers Ferry, containing less than 1,000 inhabitants. It is 44 miles from Great Falls and is not sewered, and while the conditions are thus all favorable to the healthfulness of our Potomac water, I think it would be wise to attach to the next appropriation for the Washington Aqueduct, with a special appropriation for the purpose, if necessary, a provision of law for a systematic monthly chemical and bacteriological examination of it as it is sent to the city from the distributing reservoir, the examinations to be made by the Department of Agriculture or the Smithsonian Institution, and the results to be sent to this office for publication in the annual reports of the Washington Aqueduct.

I will now proceed to describe the two principal systems of filtration and state the cost of each system.

Mechanical or rapid filtration.—"Mechanical filtration is a somewhat

broad term used to denote those systems of water purification in which an exceedingly rapid rate of filtration is made possible by means of mechanical devices for frequent, quick, and thorough washings of the filtering materials without removing them from the filter."

The filters of this system, which is called the American system, are cylinders of iron or steel containing filtering material, which is generally sand, and are extensively used by paper-makers, bottlers, brewers, ice-makers, laundrymen, and in other similar occupations. They are used also for the filtration of the public water supplies of several American cities, but so far none of the larger cities of this country have established filtration works for their entire water supplies. The cylinders are made vertical, in sizes up to 12½ feet in diameter and 16 feet high, and horizontal, in sizes up to 7½ feet in diameter and 35 feet long. The numbers of filters are regulated by the quantity of water to be filtered. The cleansing of the sand is ordinarily done by means of a reverse current of water during the stirring up of the sand by a rake with long vertical teeth, which is revolved horizontally by machinery through the sand. The cleansing is done daily or oftener, depending on the turbidity of the water.

In the American system the fall in the column of water above the sand is at the rate of 5 inches or more a minute, making a yield of filtered water of 3,000 to 4,000 gallons per square foot of filter surface per diem. This rapid rate is produced either by a great pressure or head of water on the sand by which the water is forced at a rapid rate through it, or by frequent cleansing of the sand for the purpose of removing obstructions to a rapid passage of the water, or by both.

The objection to the first is that fissures or channels are liable to be forced through the sand through which the water may pass without any modification, and the objection to the second is that clean sand alone does not make an effective filter against bacteria contained in the water. This latter objection, it is claimed, has been overcome by the use of alum, which is said to combine with the carbonate of lime, existing to a greater or less degree in all natural waters, and to form a jelly-like substance (hydrate of alumina) on the surface and in the interstices of the sand, which collects and retains the bacteria contained in the water until, after the stopping of the inflow, the reverse current is turned on and the sand is cleaned.

The amount of alum used, which varies with the turbidity of the water, is ordinarily about three-fifths of a grain to a gallon of water. It is one of the principal items of expense in this system. At Atlanta, Ga., 70,032 pounds of alum were used in filtering the 756,762,600 gallons of water used by that city in 1889. At this rate there would be required for our Washington supply of about 50,000,000 gallons per diem 5,200 pounds of alum per diem, or 1,905,300 pounds per annum, the cost of which, at 2 cents per pound, would be $38,106.

By some the use of alum is objected to as dangerous to health, but it is claimed by the owners of the patent and makers of the filters that no alum passes through the sand and that none can be found in water filtered by this system when the process is used as directed. Many testimonials to this effect and of the general excellence of this system accompany the advertisements of these filters, but this, it may be remarked, is the case with the advertisements of all patented articles.

There is one point in connection with these filters that I have not seen mentioned. After the sand has been cleansed, and the water again passes downward through the sand, a certain time must elapse before the alumina jelly, on which the efficiency of the filter as against the bacteria depends, is again formed on the surface and in the inter-

stices of the sand and replaces that which has been washed away by the reverse current, together with the dirt retained by the filter. Until this time it is obvious that the water passing through the filter should be wasted and not sent into the mains, but as far as I have observed this has not been done in any use of this system for the purification of public water supplies.

In my judgment this system should in no case be applied to our Washington water supply, which would require probably two hundred or more filters of the largest size, before it has been thoroughly tested without expense to the United States or the District of Columbia. This could be done at a cost not exceeding $5,000 by means of a single filter through which is made to pass, for such length of time as may be deemed expedient, water filled with bacteria, cultivated for the purpose, if necessary, and comparing the results with the known results* of the other system of filters about to be described. The test for color should also be made at the same time, and the water for testing should be taken from the conduit immediately after one of our heavy spring freshets.

Natural or slow filtration.—This is the system that has been in use for the purification of public water supplies of Europe for a very long period. The water of London, Berlin, Hamburg, and other large cities is filtered by this system, the most extensive application of it being at London, where about 200,000,000 gallons are filtered daily. The system has also been in use in several cities of this country, and is not patented.

A filter (filter bed) of this system is a small basin generally of an acre or less in size, with water-tight side walls of masonry or of earth paved with masonry. The number of beds required in any case depends on the daily supply of filtered water required. On the bottom of the bed, which is also water-tight, a large drain extends longitudinally from end to end of the bed and discharges through the wall into a filtered water basin. From this central drain extend, so as to drain every part of the bed, small drains of perforated tile pipes. Above this system of small drains are placed several layers of filtering material, increasing in fineness to the top. The lower layer is generally formed of small stones or broken stone, then, proceeding upward, there is coarse gravel, then fine gravel, then coarse sand, and lastly, at top, the filtering material proper, which is fine sand. The aggregate depth of the layers and the depth of each layer are not uniform in the different countries and in the different cities of the same country, but they vary with the materials available and the judgment of the engineers. The aggregate thickness of the layers is usually from 6 to 8 feet and the thickness of the sand is from 2 to 4 feet. On this latter depth; the depth or pressure of water on the sand, and the degree of cleanness of the sand, mainly depend the vertical rate of fall of the column of water above the sand, the rate and the duration of the percolation of water through the sand, and the yield of filtered water per square foot of filter surface, and on them, in turn, depends the degree of efficiency of the filter, especially as against bacteria.

It has been stated in the foregoing description of mechanical filters that clean sand alone is not effective as against bacteria and that with the use of these filters it is found necessary to dissolve alum in the water to be filtered; that this forms a jelly-like substance on the surface and in the interstices of the sand, and this, it is claimed, prevents bacteria from passing through these filters.

* A reduction of bacteria of 99.9 per cent at Berlin.

In the European or natural system of slow filtration, the efficiency of the filters depends on the slimy deposit that commences at once to form on the surface of the sand and in its interstices, and which, when in sufficient quantity, not only collects, but consumes and destroys the bacteria.* †

When the deposit forms to such a degree as to impede too much the percolation of water, the upper portion of the sand is removed, and at proper intervals the entire body of sand is replaced by fresh sand.

From time to time, as is found necessary, the water is drained from the sand and the filter is allowed to rest. The air which replaces the water oxidizes any organic matter that remains in the sand.

In order to protect the water from the heat of summer and from freezing in winter filter beds in this climate should be roofed.

When a filter bed is first put in operation and afterwards, after each of these changes, the water passing through the filter is allowed to run to waste for about ten days or two weeks until it is found to be chemically and bacteriologically pure by a chemist and biologist constantly employed at the filtration works.

The vertical rate of fall of water in the European system is not allowed to exceed a rate of about 4 inches an hour, making a yield of filtered water of from 50 to 100 gallons per square foot of filter surface. As has been stated, the rate of vertical fall of the column of water above the sand in the mechanical or American system is 5 inches or more a minute or 25 feet or more an hour, making a yield of 3,000 to 4,000 gallons per diem of filtered water per square foot of filter surface. The interstices in the sand, occupying as they do about one-third of the body of the sand, the downward rate of percolation through the sand in the European

* "It is easy to see how the filters remove the dirt and suspended, matter, but the way in which bacteria were eliminated was a complete mystery until the last four or five years. But few people had ever seen or examined bacteria before that period. It now has been shown that the bacteria remove the bacteria. The bacteria in the waters are comparatively few of a dangerous character; the great bulk of them are our greatest friends. It is through their aid, together with the oxygen of the air, that the filth in the water is destroyed. They feed upon it and they feed upon each other. Since that knowledge has been obtained, the object now is to cultivate the bacteria. In order to make the filter bed do its work effectively it is necessary that the growth of the bacteria shall be facilitated until a filter bed becomes populated with an incredible number of millions of them. As the result of their activity they multiply themselves in vast numbers, and they form, at the top of the filter beds and between particles of sand, a sort of jelly or slime—a bacteria jelly—and it is by the aid of this bacteria jelly that the bacteria in the unfiltered water are removed." (Prof. Leeds, of Stevens Institute.)

† "On examining with the microscope the surfaces of the particles of sand when the filter is in perfect working order, they are found to be coated with a greasy, slimy substance, which is a mass of bacteria jelly. It is to this coating of bacteria jelly that Peifke attributes the efficiency of these filters, and until the jelly forms in sufficient amount to completely envelop each particle of sand the filter works imperfectly. This, then, is his explanation of the fact that minute microorganisms and particles of clay of infinitely smaller size than the channels in the sand are stopped in their passage through it—they are simply caught in this slimy coating and can not get farther."

The latter extract is from a paper by Thomas M. Drown, read before the Boston Society of Civil Engineers and published in the Journal of the Association of Engineering Societies, July, 1890. In the advertisements of the American filters it is stated that the jelly of hydrate of alumina used with them is a far more cleanly agent than the jelly above described and this forms one of the chief claims of excellence of the American system, but it should be remembered that as the deposit of bacteria, etc., from the water commences to form on the surface and in the interstices of the sand in the American system as soon as the filtration commences and constantly increases in quantity until the sand is cleansed, the filtering in the American system is also done through the jelly formed in the natural system, and that this can not be avoided in any system of filteration.

system is therefore about 1 foot an hour, and in the American system is about 75 feet or more an hour. The depth of sand in the European system being on an average, say 3 feet, and in the American system on an average say 5 feet, it follows that water in process of filtering is, in the European system, in contact with the filtering sand about three hours and in the American system about four minutes.

In Europe no subject connected with health has had in recent years so much careful and scientific investigation as the filtration of public water supplies. The Imperial Board of Health of Berlin, of which Prof. Koch, the discoverer of the microbes of consumption and cholera, is a member, has formulated the rules by which filtration should be conducted. In this country also, especially at Lawrence, Mass., the experiments with filtration have been most thorough and conclusive.

On a statement by the State Board of Health of Massachusetts that "no mechanical filter examined by it removed enough bacteria to warrant the board in recommending the city to accept it," the city of Lawrence entered upon the construction of a system of natural filtration works which for efficiency are probably not excelled in any country, and the result has been that typhoid fever, from which the city formerly suffered severely by reason of pollution of its water supply (the river Merrimac) from the sewered city of Lowell a few miles above, has been almost completely eradicated.

COST OF FILTRATION WORKS AND COST OF MAINTENANCE.

The city of Providence, R. I., has very recently had in competition as to cost the two systems of filtration, and it furnishes the basis of close calculations as to the first cost and cost of maintenance of the two systems if applied to the Washington water supply.

I quote the following extracts from a letter dated July 26 last, that I received from Mr. J. Herbert Shedd, city engineer of Providence, in answer to my inquiries:

> The proposition to furnish mechanical filters to the city of Providence included the erection of 60 steel filters, 12 feet 8 inches in diameter and 16 feet high, with all suitable appurtenances and piping, housed in a brick building about 52 by 370 feet, with an engine-room annex 51 by 62 feet for $280,896. There was also nacluded $15,000 for earth filling about the building and $1,100 for raising the standpipe to give the necessary increased pressure required by the loss of head through the filters. This provides for the filtration of 15,000,000 gallons per day, but at a rither slower rate than the filter company deemed necessary, they thinking it practicable to do the work with 45 such filter tanks. The estimated cost of maintaining these filters based upon our experiments is as follows:

Sulphate of alumina at 2 cents, including delivery			$25.70
Engineers, 2 men, at $2.50		$5.00	
Washing, 2 men, at $2		4.00	
Firemen, 2 men, at $2		4.00	
Irregular washing, 2 men, at $2		4.00	
			17.00
Water for washing, at $10 per 1,000,000 gallons			7.35
Water for rewashing			4.35
Caustic soda			16.35
Waste and oil			.50
Coal:	Pounds.		
Pumps	2,666		
Stirring	2,000		
Lighting	1,500		
Sundries	1,067		
	7,233=3.61 tons, at $5.		18.05
Biological and chemical assistant			5.00
Daily cost, say			94.30

The proposed constrution for natural filtration, provided for six basins having an effective filtration area each of 150 by 300 feet, making a little over an acre for each bed with necessary inlets, with racks, screens, channels, pipes, gates, etc., to take the water from the river as now existing through the filters and into the clear well now existing. These beds would filter 15,000,000 gallons per day, passing a vertical depth of about 3 inches per hour and at the rate of about 2,000,000 imperial gallons per acre. My estimate of the cost of doing this work was $208.000. A bid has been received from responsible contractors offering to do the work for $200,000.

From the best information I am able to obtain as to the cost of maintaining and cleaning these filters, the cost ought not to exceed $1 per million gallons per day. If we add to this $5 per day for biological assistant to make it comparable with our estimate of cost of maintaining the mechanical filter, we should have relatively $20 per day for natural filtration and about $94 per day for filtration with alum.

* * * * * * *

The color of our water, which is not high, is reduced about one-half by slow filtration. It is reduced a little more, but not to a marked degree, by the use of alum. The color of the Boston water supply is reduced about one-half by slow filtration without alum. The color of the Hudson river water at Poughkeepsie is not much reduced by slow filtration. It can be nearly removed by the use of alum, but to do this requires an excessive amount of the chemical. The Massachusetts board of health found at Brockton that quite an inadmissible amount of alum was necessary to clarify the water by that process.

The first cost and the annual cost of maintenance of the works required for the filtration of the water now consumed and wasted in Washington, about 50,000,000 gallons per diem, and also for the filtration of 75,000,000 gallons per diem (to which amount our consumption and waste will probably attain considerably within ten years) at the above rates (after deducting the cost of earth works and raising the standpipe from the price of the mechanical filters at Providence) would be as follows:

First cost (50,000,000 gallons per diem):	
For natural or slow filtration	$666,667
For mechanical or rapid filtration	883,000
First cost (75,000,000 gallons per diem):	
For natural or slow filtration	1,000,000
For mechanical or rapid filtration	1,324,500

These amounts do not include the cost of the land required for the filtration works, the cost of filtered water basins, or the cost of the changes that would be required at the reservoirs.

Annual cost of maintenance (50,000,000 gallons per diem):	
For natural or slow filtration	$24,333.33
For mechanical or rapid filtration	114,366.67
Annual cost of maintenance (75,000,000 gallons per diem):	
For natural or slow filtration	36,500.00
For mechanical or rapid filtration	171,550.00

CONCLUSION.

Under present conditions there appears to be no cause for apprehension respecting the healthfulness of Potomac water as delivered by the river into the intake of the aqueduct at Great Falls.

It appears that without the use of alum, or with this use if the alum be used in quantities not prejudicial to health, the color of the water that exists after freshets in the Potomac can only be partially removed by filtration.

For these reasons, and for the reason that of the 200 gallons of water or more per capita per diem that are consumed and wasted, it is probable that not more than an average of 50 gallons, or one-quarter, is used for strictly domestic purposes, and that this portion in its delivery through the mains can not be separated from the remainder, it seems to me beyond doubt that as long as the present conditions continue the great expenditures that would be required for the first cost of filtration

works for our water supply, and the annual cost of maintenance of these works would not be justifiable, and that, for the present at least, reliance should be had on sedimentation.

It is expected that when the works of improvement required for restoring to use the Dalecarlia receiving reservoir shall have been completed, at the end of this fiscal year, the time during which the water may be "settled" before it is sent to the city from the distributing reservoir will be so much increased (it will be doubled) that the condition of the water as to color after high-water and freshets in the Potomac and its tributaries will be much improved, and that when the new reservoir near Howard University, which is to contain 300,000,000 gallons of water, shall have been finished and brought into use, there will be but little to be desired in respect of the quality of our water supply.

In Appendix 5 will be found a copy of a useful and interesting paper on the subject of natural or slow filtration by Prof. William T. Sedgwick of the Massachusetts Institute of Technology.

MEASUREMENT OF DAILY AND HOURLY CONSUMPTION AND WASTE OF WATER.

[Hourly and total flow from the distributing reservoir for the twenty-four hours ending at 8 a. m. June 28, 1894. City temperature in the shade at 2 p. m. June 27, 86°.]

Hour.	Outflow per hour.	Hour.	Outflow per hour.
June 27, from—	*Gallons.*	June 27, from—	*Gallons.*
8 a. m. to 9 a. m	2, 218, 490	10 p. m. to 11 p. m	1, 905, 082
9 a. m. to 10 a. m	2, 215, 097	11 p. m. to 12 midnight	1, 631, 037
10 a. m. to 11 a. m	2, 350, 314	June 28, from—	
11 a. m. to 12 noon	2, 070, 912	12 midnight to 1 a. m	1, 900, 670
12 noon to 1 p. m	2, 205, 886	1 a. m. to 2 a. m	1, 491, 718
1 p. m. to 2 p. m	2, 065, 338	2 a. m. to 3 a. m	1, 490, 251
2 p. m. to 3 p. m	2, 199, 958	3 a. m. to 4 a. m	1, 759, 315
3 p. m. to 4 p. m	2, 059, 632	4 a. m. to 5 a. m	1, 892, 357
4 p. m. to 5 p. m	2, 193, 768	5 a. m. to 6 a. m	2, 159, 785
5 p. m. to 6 p. m	2, 190, 857	6 a. m. to 7 a. m	2, 560, 715
6 p. m. to 7 p. m	2, 051, 036	7 a. m. to 8 a. m	3, 093, 959
7 p. m. to 8 p. m	2, 048, 340		
8 p. m. to 9 p. m	1, 773, 022	Total	49, 162, 357
9 p. m. to 10 p. m	1, 634, 818		

Measurements of daily consumption and waste of water in the city in the last fiscal year.

Date.	Gallons.
Thursday, March 29, 1894	43, 505, 274
Thursday, June 28, 1894	49, 162, 357

By reason of leaks in the gates in the dam at waste weir No. 2 which interfered with the work of excavation of the main drainage tunnel at the Dalecarlia receiving reservoir, and which would be increased by lowering and raising the water in the conduit, and by reason also that the falling off of the supply from Great Falls rendered it unwise to diminish the head of water in the distributing reservoir when it could be avoided, I measured the daily consumption and waste but twice in the fiscal year.

Consumption and waste of water in the city, as measured annually in the latter part of June of each year, from 1874 to 1894, both inclusive.

Year.	Gallons.	Year.	Gallons.	Year.	Gallons.
1874	17,554,848	1881	26,525,991	1888	29,115,774
1875	21,000,000	1882	29,727,864	1889	27,708,779
1876	24,177,797	1883	24,314,715	1890*	35,541,845
1877	23,252,932	1884	24,827,113	1891	38,594,743
1878	24,885,945	1885	25,219,194	1892	41,161,780
1879	25,947,642	1886	25,542,476	1893	46,727,108
1880	25,740,138	1887	26,878,424	1894	49,162,357

* Forty-eight-inch main added to the supply.

It will have been observed from the above table that the consumption and waste in the city has increased from about 27,500,000 gallons per day in 1889, the year before the 48-inch main was put in operation, to more than 49,000,000, or nearly double the former quantity.

The last census (the police census of June, 1892) of the cities of Washington and Georgetown found that the population, excluding the "county," was 228,002. Dividing this number into the number of gallons of water consumed and wasted on June 28 we find the daily rate per capita to be 215 gallons.

While this calculation is not strictly accurate, for the reason that it excludes the unknown increase of population since June, 1892, and for the further reason that while the major portion of the population of the "county" is not supplied with Potomac water a comparatively small number of persons in that section is so supplied, it is sufficiently close to show that the quantity of water wasted is greater than can be afforded before the supply from Great Falls can be increased by the raising of the height of the dam as urged elsewhere in this report.

No complaints as to the condition of the water, except in respect of its turbidity, have been made during the year.

Statements of the condition of the water in the distributing reservoir as it is supplied to the mains leading to the city after passing through the reservoir will be found in Appendix 1. A copy has been furnished monthly to the Museum of Hygiene of the Navy Department since June, 1891, at the request of the medical director in charge. A statement of the total number of days during the fiscal year 1893-'94 on which the water at Great Falls, at the Dalecarlia receiving reservoir, and at the distributing reservoir was clear, slightly turbid, turbid, and very turbid will be found in the same appendix.

A table showing the pressures on the United States mains for every day in the year, as recorded on the gauges in the office of the Washington Aqueduct, will be found in Appendix 2.

MISCELLANEOUS.

In addition to the foregoing work of the last fiscal year, stated under the appropriate headings, I have to note the following:

An examination of the telephone line that connects the two reservoirs and Great Falls with this office, showing that many of the poles were decayed and in an unsafe condition, the butts of 65 poles were cut off and the poles reset and 9 new poles were planted.

The District authorities having changed the system of sewerage for the block in which the aqueduct office is situated, in order to allow the closing up of an open sewer that was a menace to the health of the vicinity, it was found necessary to lay a special sewer from the office to Rock Creek, which was done in January.

Extensive repairs were made on the aqueduct stable, on the fence at the distributing reservoir, and in this office.

Shade trees (alternate lindens and tulip trees) were planted at the distributing reservoir to replace some of those that had been planted in the previous fiscal year and had failed to live.

On May 28 I inspected the sandstone quarries at Seneca, Md., pertaining to the Washington Aqueduct.

The Secretary of War on January 9, 1894, granted to J. P. Clark a revocable license to construct a plank walk along the Conduit road from Foxhall road to Albany street.

Strong iron doors were hung at the outlet from the waste gate in the dam at wasteweir No. 3 and at the openings to the chambers in the abutments of Cabin John bridge to prevent access to these chambers of unauthorized persons.

Supt. R. C. Smead, Chief Clerk Simon Newton until January, 1894, and Pickering Dodge since that date, valve-tender and machinist Thomas Ferguson, and the other employés of the aqueduct have been faithful in the performance of their responsible duties. Thomas Sullivan, John Halloran, and Daniel Harrington, for many years watchmen gatekeepers at Great Falls and at the reservoirs, in addition to their other duties, have skillfully and energetically acted as foremen of laborers engaged on the works of repair of their respective divisions of the aqueduct.

On reference from the Chief of Engineers reports on the following bills introduced in the Fifty-third Congress, first and second sessions, have been made by me during the fiscal year:

S. 871, Fifty-third Congress, first session, "A bill to authorize the Norfolk and Western Railroad Company, of Virginia, to extend its line of road into and within the District of Columbia, and for other purposes."

H. R. 6040, Fifty-third Congress, second session, "A bill to amend an act entitled 'An act to incorporate the Washington and Great Falls Electric Railway Company.'"

S. 1359, Fifty-third Congress, second session, "A bill to amend an act approved July fifteenth, eighteen hundred and eighty-two, entitled 'An act to increase the water supply of the city of Washington, and for other purposes.'"

S. 1960, Fifty-third Congress, second session, "A bill to authorize the Great Falls Power Company to use electricity for light and power purposes in the District of Columbia."

S. 2118 (H. R. 7502), Fifty-third Congress, second session, "A bill authorizing the sale of title of United States to a tract of land in Montgomery County, Maryland, to William H. and George Bobinger."

The Secretary of War on May 14, 1894, granted permission to the Commissioners of the District of Columbia to construct under specified conditions a sewer from the Girls' Reform School across the Conduit road and the aqueduct lands to Little Falls Branch, below the dam of Dalecarlia receiving reservoir.

On the request of the District water office, permission was granted to raise the height of the water in the high-service reservoir on Road street in Georgetown 2½ feet, or to the height of 220½ feet above datum.

EXPLANATIONS OF ESTIMATES.

It is my duty to call especial attention to several works that are urgently needed. Most of them were mentioned in my last annual report, and in several previous reports, but have not been acted on by Congress.

Raising the height of the dam at Great Falls.—Respecting this work I quote the following from my last annual report:

During the last summer and fall the Potomac at Great Falls was at a lower stage than has ever before been known within the memory of the oldest inhabitant. On seventy-two days the gauge above the dam showed a depth of water on the dam of only about 7 inches, and on five days it showed but 6 inches. The crown of the conduit arch at Great Falls is 151 feet above datum and the crest of the dam is 148 feet above datum. The conduit was therefore (in respect of its diameter) only about three-fourths full at its head. A similar deficiency now obtains every year during the time of low water at Great Falls, and at such times, the weather being usually hot and dry and the consumption and waste in the city greatly increased, I have found ever since I laid the 48-inch main that the height of the dam is not sufficient during a considerable portion of every year to enable the conduit to deliver into the distributing reservoir as much water as is now consumed and wasted in the city, *and at the same time keep up the head in the mains to 146 feet above datum, which is necessary for the supply by gravity of the high northern portions of the city and of Capitol Hill.* The only remedy for this deficiency, which reduces pressures everywhere in the city and is annually increasing, except the enactment of a law requiring the use of meters by all consumers of Potomac water, is one that must be made before any further steps are taken for increasing the supply from the distributing reservoir, either by the tunnel to the new reservoir near Howard University, or by another main. It is the raising the height of the dam at Great Falls. In other words, before providing additional means of supplying to the city more water *from* the distributing reservoir, it will be necessary to be able to send more water from Great Falls *into* this reservoir.

I estimate the cost of raising the height of the dam, together with the cost of such other works as may be found necessary in connection therewith, including the cost of strengthening the conduit and including also payment for damages on account of flooding of lands and other damages, at $125,000.

As soon as an appropriation can be had for the work it is proposed to raise the height of the dam 2½ feet, or to the height of 150.5 feet above datum. This would not only have the effect of filling the conduit at its intake at the lowest stages of the river, but the increase in the head of the water over the distributing reservoir would increase the velocity through the conduit, and the result would be an estimated increase in the supply to the reservoir of about 20,000,000 gallons per diem.*

I find among the interesting and instructive notes that I received from the late Gen. Meigs and have carefully filed for the information of the officers in future charge of the aqueduct, one dated March 1, 1891, of which the following is an extract:

The original design was to set the lip of the dam at the Great Falls at the height of 150 feet above tide, for which height all the profiles and wasteweirs were built. The back filling over the conduit would now allow a height of water some 2 feet higher than the dam to flow safely through the conduit, and, if needed, another foot or two and corresponding widening of the embankments would fit the aqueduct to convey, with increased height of dam lip, a very much increased flow of water to the city.

Improving the Dalecarlia receiving reservoir.—One of the most beneficial appropriations ever made for the Washington Aqueduct since its completion in 1863 was the appropriation of $60,000 made in the act of March 3, 1893, for improving the receiving reservoir by the works required for cutting off the drainage into it of polluted waters and sewage from the surrounding country, for the purchase or condemnation of the small amount of land required for the purpose, and for the excavation necessary at the head of the reservoir, with the provisions that the whole cost of the work shall not exceed $150,000, and that the work

* This is under the supposition that the appropriation hereinafter recommended will be made for removing the accumulation of deposits in the conduit.

should be done by contract or otherwise, as the Secretary of War might determine.

The object and plan of this improvement were fully described in my last annual report, and the work accomplished during the last fiscal year has been stated in detail in this report under the heading "The reservoirs." By means of the $60,000 appropriated for the work the main drainage tunnel under Dalecarlia hill, nearly 1,000 feet long, has been completely finished, and it has been very carefully lined with brick, exhausting the appropriation.

There remains to be done a short tunnel through the hill which lies to the east of Little Falls branch, the open channels between the three streams that empty into the reservoir, and the permanent dams across these streams. The estimate submitted is necessary for these purposes, and it is earnestly hoped that this amount will be appropriated before the close of the current session of Congress for the completion of the work.*

Storage yard.—In my last annual report I stated the necessity for a yard near the aqueduct office for the storage of articles that are necessary for repairing any breaks that may occur in the 21 miles of trunk mains belonging to the United States. The storage yard on the bank of Rock Creek, in rear of and pertaining to the aqueduct office, is entirely unsuited to the purpose. It is too low, and the route from it to the level of the street being steep and tortuous, before the very heavy castings required for these repairs could be hauled out much damage and destruction of property might be done. I quote my former remarks on this subject and renew the estimate submitted:

I have provided supplies for use in case of breaks in the 48-inch and other mains, comprising sections of pipe, curves, crosses, reducers, sleeves, etc., a heavy wagon for hauling them where needed, lifting jacks, and efficient pumps; also machinery for lowering the pipes in the trenches, and the implements and material required for handling and calking.

A portion of these supplies has been placed in a yard which I have arranged on the public land at the distributing reservoir, for use in the country portions of the routes of the mains, and the remainder for use in the city portions of these routes has been placed in a portion of Twenty-seventh street, near M-street bridge, which has been loaned for the purpose by the District government until the street is wanted for improvement.

As we shall not be able, probably, to retain this place, exceptfor a short time, a permanent yard in the city should be purchased for use as a storage yard. It should be near this office, and at or near the grade of the street, so that the heavy castings and machinery required for repairs can be quickly gotten out.

I believe that a suitable lot can be obtained by purchase, or if need be by condemnation, for $10,000, and I recommend an appropriation of this amount for the purpose.

In my last annual report and in several previous annual reports, I called attention to several other works that in my judgment were required for the improvement, the preservation and repair of the aqueduct, and submitted estimates of their cost. No appropriations having been made for these works I renew the estimates of their cost and restate explanations of their necessity:

Widening the macadam pavement of the Conduit road.—The present macadam pavement of the Conduit road was only made wide enough (about 12 feet) to prevent the earth-covering of the arch of the masonry conduit under the road from being cut through by travel in spring, and at other times when the ground is softened by rain. The travel on the road in good weather, and especially on Sundays and other holidays, has increased so enormously that collisions are frequent. Wrecks of vehicles are often seen along the sides of the road on Mondays, and there is constantly danger of serious accidents by collision on the narrow pavement of this road.

The greater portion of the Conduit road is beyond the District line, but it and the

* Since this report was written the sum of $52,500 has been appropriated for continuing this work, leaving the amount yet to be appropriated $37,500.

strip of land through which it passes belong entirely to the United States. It is almost the only, if not quite the only, road out of the city that has not been spoiled for driving purposes by street railways. It is one of the most picturesque roads in the country, extending far up into Maryland amid the fine scenery along the Potomac, and it is the only route to the city that is available for a large number of the farmers of Montgomery County. Congress has refused to allow the road or any part of the strip of land referred to to be occupied for railroad purposes, and in its charter for a railway on private lands south of the Conduit road and parallel to it (that of the Washington and Great Falls Electric Railway) the marring of the beauties of the road was carefully guarded against, and the construction of more than one line of railway near the Conduit road was prohibited.

The macadam pavement should be widened to a width of 30 feet. The depth of the new portions should be 13 inches, including 8 inches of large stone, 4 inches of small broken stone, and 1 inch of binder. There should be a wide-paved gutter and a line of shade trees (preferably alternate lindens and tulip trees, on each side of the road, and the slopes of embankments should everywhere be sodded. This plan will require the widening of the roadbed at several places by adding to the width of the embankments over the culverts that pass under the aqueduct, by cutting away embankments on the upper side of the road, and by filling on its lower side.

I estimate that the cost of the work required for that part of the road that lies between the auxiliary gatehouse at the distributing reservoir and the foot of Dalecarlia hill, a distance of 13,200 feet, or about 2½ miles, will be $34,500, and an estimate for it is submitted in the list of estimates. The remaining distance to Cabin John Bridge, which is the limit of the major part of the travel at present, is about 3 miles. It will probably not be necessary to extend the improvement of the road beyond this point for several years.

In addition to widening the pavement of the Conduit road as herein proposed, a width of 100 feet, or such other width as may be necessary, on each side of the road, should be purchased or condemned for the purpose of parking it, and with the additional object of controlling the land abutting on the road and excluding the liquor saloons that now exist and are increasing, and to which many of the collisions on the road are doubtless attributable.

I may remark that when the late Gen. Meigs constructed the Washington Aqueduct (it was commenced in 1853 and essentially finished in 1863) there was no road along it or in its vicinity, and the only road from Washington to Great Falls was via the Rockville road and the "River" road, which ran and now runs from Tennallytown to the Falls; but the route over the conduit being shorter and until the hills around the Falls are reached comparatively level (the road has essentially the same grade as the conduit beneath it, viz, 9½ inches to the mile, or, more accurately, 9 inches in 5,000 feet, or 0.00015), it soon attracted travel, which has been constantly increasing.

Raising the masonry casings of the manholes along the line of the aqueduct.—When the water in the distributing reservoir is at its normal height of 146 feet above datum, there is a pressure of something over 4 feet of water at the crown of the conduit arch where the conduit enters the reservoir, and the water in the conduit is backed up and the crown of the arch is under pressure about as far up as Bridge No. 3, or Griffiths Park bridge, the bridge next above Cabin John bridge. I found when I uncovered the manholes along the line of the conduit for use in my inspection of its interior from Great Falls to the distributing reservoir in September, 1891, that the tops of several of the casings of the manholes below this point are below the gradient or slope of the water, so that when the manholes are uncovered it is found above the manhole covers, and in some instances more than a foot in depth above them. No harm has thus far resulted from this state of affairs, but the casings of the manholes wherever necessary (I have a record of them) should be raised above the gradient, so as to prevent the soakage of the ground around the manholes. An estimate of $600 for this work is submitted.*

Lowering the height of the cross dam in the distributing reservoir.—The lower reservoir (the distributing reservoir) is divided about halfway between the influent and effluent gatehouses by a cross dam, in the middle of the length of which is a narrow cut lined with masonry, through which all the water on its way to the effluent gatehouse, where it enters the mains, must pass.

The draft through this cut is so strong that the major part of the water is drawn straight from the influent gatehouse, which is in an angle of the upper division (the settling division), to the cut, so that when the water is turbid it does not diffuse itself through the whole body of water in this division (110,000,000 gallons) as it should, in order that the greatest amount of settling be done.

Neither is the water after it passes through the cut properly distributed through the lower division, which contains about 60,000,000 gallons, for the reason that the draft from the cut to the head of the mains leading to the city from the lower end

* This work must be done before the height of the dam at Great Falls is raised.

of the division is so strong that the water all passes in a comparatively narrow stream straight to these mains, so that it also gets very little chance to settle in this division.

Now, as the upper portion of any body of water not quite free of turbidity, and in the process of settling, is the clearest, if the top of the dam be lowered far enough to allow only a thin sheet (at the present rate of consumption it would be about an inch deep) of water to pass over the dam, as was Gen. Meigs's design, we should have in each division a very effective additional means of clarifying the aqueduct water, and I believe that this improvement in the distributing reservoir being made, and the Dalecarlia receiving reservoir being improved as has been provided for in the act of March 3, 1893, there would be but rarely, if any, complaint of muddy water.

I estimate the cost of this improvement at the distributing reservoir by lowering the cross dam at $12,500.*

Protection of the inlet to the conduit at Great Falls.—The bank of the Chesapeake and Ohio Canal, which runs parallel to the Potomac at Great Falls, and about 150 feet from it, is about 16½ feet higher than the uncovered chamber, just above the Maryland end of the aqueduct dam that forms the inlet from the river to the conduit.

In the flood of November, 1877, which rose at Great Falls to the height of 160 feet above the datum of the aqueduct, or 12 feet higher than the crest of the dam, the canal bank at a point opposite the inlet was washed down to the river and a part of it into the inlet. I quote from the annual report of the aqueduct for 1878:

"The masonry forming the arch of the feeder was uncovered from a point near the middle of the canal to the mouth of the feeder, a distance of 150 feet. The chamber at the head of the aqueduct was filled with stones that had formed the slope wall of the canal, and the aqueduct feeder for a distance of 300 feet was filled with débris to depths varying from 3 to 6 feet, so as to entirely stop the flow of water during the ordinary low stages of the river."

In the still higher flood of June, 1889, *which rose to the height of 16 feet over the aqueduct dam*, the canal bank was again washed down to the river, but fortunately the damage did not occur immediately opposite the inlet to the conduit, but from 200 to 400 feet higher up, so that the major part of the débris being left on the margin of the river and a part of it being carried over the dam, not so much filling of the inlet to the conduit was done, but, as in the flood of 1877, it was partially obstructed.

The annual report of the aqueduct for 1889 says:

"The banks of the Chesapeake and Ohio Canal above and below the mouth of the conduit were carried away and that opposite the conduit was threatened. A number of men were kept at work on this bank during the freshet, and it is believed that had it not been for the energetic work of this force and the widening and strengthening of the bank at this locality in April, great damages would have occurred at the mouth of the conduit."

It will be observed that in the freshet of 1877 not only the inlet chamber, but the conduit itself was filled with débris to a depth of from 3 to 6 feet *for a distance of 300 feet in from its mouth*, but, the water in the river being at a high stage, there was still waterway enough in the conduit above the débris to enable the supply to the city to be kept up. Had a complete closure of the mouth of the conduit occurred, with 12 to 16 feet of water over it, there would have been no possible way, with the torrent raging over the mouth, to remove the obstruction before the river subsided, and the water supply to the city would have been cut off.

There is no more important part of our system of water supply to be carefully guarded than the head of the conduit at Great Falls, and in order to avert dangers like those of 1877 and 1889, to which the water supply is liable in every freshet, a masonry wall should be built between the river and the canal, rising a few feet higher than the latter, and extending upriver from the mouth of the conduit as far as the limit of the Government land, and thence, at about a right angle, and still on the Government land to the shore of the river. I estimate the cost of this wall at $5,000.

Cleaning the bottom of the distributing reservoir.—The sedimentary deposits of about 20 years, within which time the distributing reservoir has not been cleaned out, have raised the bottom of its upper division (the settling division) about 9 inches, and of the lower division about 4 inches.

These deposits have diminished the capacity of the reservoir about 8,000,000 gallons, and, although it is probable that these deposits, which are mostly clay, are not deleterious to the water, they should be removed as soon as an appropriation

* This work need not be done before the height of the dam at Great Falls is raised, and the height of water in the distributing reservoir can be maintained at the constant level of reference (146).

can be obtained for the purpose. It would require the removal of about 39,500 cubic yards, the estimated cost of which, at 35 cents per cubic yard, is $13,825.

Storehouse at Great Falls.—There is no place for storage of the public property at Great Falls, or for cement and other materials required when any work of construction or repairs is going on on that division of the aqueduct. A storehouse is urgently needed, and I propose to erect one about 40 by 20 feet in size, at a cost of about $1,500. The Chesapeake and Ohio Canal is now in operation, and the stone for the walls can be cheaply obtained from the Government quarry at Seneca, a short distance above the falls.

Inserting air valves and blow-off valves in the 30-inch and 36-inch mains.—In respect of this estimate I beg leave to quote from my annual report of 1890, as follows:

"It is important that more efficient facilities be provided for emptying and filling the old mains in case of accident, and of making connection from main to main.

"In either case a section of the main must be cut out and a new piece inserted, but before this can be done the main valve, at whatever distance on either side, must be shut, and the section of the main between these two valves, generally more than a mile long, must be emptied of its water. The time required for emptying depends not only on the sizes of the blow-offs in the valleys crossed by the mains, but also on the sizes of the air valves provided at the summits, for the water can not, of course, in any case be gotten out of a main any faster than the air required to take its place can be gotten in.

"In making the connections at New Jersey avenue and L street between the 36-inch main and the 24-inch by-pass, on the night of the 14th of April last, more than five hours were consumed in freeing the main of water, owing to insufficient blow-offs and air valves in the 36-inch main, and the refilling of the main after the connection had been made was so much prolonged by the want of proper valves for the egress of the air that it was nearly noon of the next day before the charging of the main was completed.

"Similar delays occurred at each of the numerous connections between the mains that were made after the 48-inch main was completed, and I was in each case obliged, in getting the air into the mains for emptying and out of them for filling them again with water, to have recourse not only to fire hydrants, but to the service-pipe spigots in private houses in the vicinities of these connections."

These delays are very expensive, night work costing about double the rates of day work, and the danger in case of fire in the district cut off from its supply of water is so great that large air valves and blow-off valves should be placed on both the 30 and 36 inch mains as soon as an appropriation can be obtained for the purpose. A patented device, of which I have obtained the details since the date of the report referred to, very much reduces the time required for inserting these valves, as well as their cost, and, what is very important, it enables the work to be done while the mains are under their ordinary pressure. The cost of inserting the required blow-off and air valves in the 36 and 30 inch mains will be about $6,250.

Removal of the accumulation of deposits in the conduit.—As stated in my last annual report, my inspection of the interior of the conduit from Great Falls to the distributing reservoir, in September, 1891, showed an accumulation of about 15,500 cubic yards of clayey deposits in the conduit throughout its entire length between these points of about 12 miles. These deposits, which diminish the capacity of the conduit, should be removed as soon as money can be obtained for the purpose. For the reason that the supply of water to the city must be interrupted while the work of removal is going on, a large part of it must be done at night. It will, therefore, be a tedious and expensive operation, and it can not be accomplished by means of the small annual appropriations for maintenance and repair. I include in my estimates an item of $14,000 for the removal of the deposits in the conduit, and this, if granted, would enable the entire conduit to be thoroughly cleaned out in one year.

Rebuilding the bridge over the Spillway at the Dalecarlia receiving reservoir.—The Conduit road bridge over the spillway at the Dalecarlia receiving reservoir and just beyond the District line is a wooden bridge on trestles that was built many years ago. The travel over the bridge is very heavy, it is decaying, and, in order to prevent accidents frequent repairs are necessary.

This bridge, which is of short span, should be replaced by a handsome stone bridge of an architecture commensurate with Cabin John bridge and the other masonry bridge next higher up the line of the aqueduct (Griffith's Park bridge), and I include an estimate of $18,000 for it in my annual estimates.

Deepening the distributing reservoir.—The present bottom of the distributing reservoir being at reference 135 above the aqueduct datum, and the flow line of the reservoir being at reference 146 above this datum, the available depth of water is 11 feet.

It has often been recommended in former annual reports that the depth be increased 13 feet, or to reference 122, the depth of the axes of the four 48-inch connections between the screen house and the gate chamber.

This would increase the storage capacity of the reservoir from about 170,000,000

gallons to about 290,000,000 gallons, and add to the coolness of the water and also to its purity, for, unlike the Dalecarlia receiving reservoir, which is nearly surrounded by woods, the distributing reservoir is fully exposed to waves, and the winds are sometimes so great as to disturb the bottom and make the water roily.

Should this be done, berms of 10 feet in width should be left at the foot of the present slope walls protecting the sides of the reservoir, the tops of these berms should be paved, and the deepened portions of the sides should be protected by slope walls of dry-rubble masonry 12 inches thick, laid on a broken-stone lining 6 inches thick. The cost of the work will be about $290,000.

I consider the work of deepening this reservoir to be of very great importance for the reasons given, and it should be done as soon as appropriations can be obtained for it, but as the improvement of the quality of the aqueduct water, the increase of storage capacity above the heads of our mains, the protection of the aqueduct, and other works herein mentioned are of more importance at this time, I have not included it in the estimates for the next fiscal year.*

DESIRED PROVISION OF LAW IN RESPECT OF APPROPRIATIONS FOR THE AQUEDUCT.

I renew the following statement of reasons for this provision contained in my last annual report. In my judgment the desired provision or change in the law is of the utmost importance.

The annual appropriation for maintenance and repair of the aqueduct is now a fiscal year appropriation, and its availability terminates on the 30th of June of each year. Whenever the appropriation is delayed there is liable to be a time in the early part of every other fiscal year during which, should a break occur in a main either in the city or in the country this side of the distributing reservoir or in the conduit, or should any disaster occur at the reservoirs or at Great Falls, there is no money available for repairs.

If this appropriation should be made available until expended, some of the less urgent repairs toward the end of the year could be postponed until the next appropriation should become available, so that there would always be money in hand for repairing breaks in the mains or other works of emergency.

A leak in one of the city's old and decayed street mains or in one of the hundreds of small service pipes that cross the route of the 48-inch main, for instance, by undermining it, may cause it to break, and the quantity of water that would be discharged on the street, especially in the low levels of the route, would be so enormous that the property and even the lives of citizens in the vicinity of the break might be endangered.†

Even when, in the cases of delay in the passage of the regular appropriation bills, temporary provisions are made for the expenditures of the Government, considerable lengths of time after the beginning of the fiscal year elapse before official information (which only would warrant expenditures under these provisions of law) reaches disbursing officers.‡

On the 8th of July, 1892, in blowing off the 30-inch main at Foundry Branch, the heavy bronze sleeve through which the valve stem works was badly fractured, so that the valve could not be moved before a new sleeve could be cast and turned. The regular appropriation bill had not then been passed by Congress. I had only information from newspapers that temporary provision had been made for the expenditures of the Government and I had no money to my credit for the repair of the valve. Fortunately the valve happened to be shut at the instant when the accident occurred, else it would have wasted into the Potomac the water in the distributing reservoir at the rate of about 2,000,000 gallons per hour at a time when, on account of the low stage of water in the river, we had none whatever to spare.

---

*The late Gen. Meigs, in one of his frequent notes respecting the aqueduct, in which up to his death on the 2d of January, 1892, he continued to retain the deepest interest, called my attention to the care that would be required, whenever the distributing reservoir is deepened, not to cause leaks by uncovering and cutting into the uptilted and more or less dislocated gneiss formation that he found to underlie some portions of the reservoir.

†The internal pressure on our mains at some portions of their routes is about 43 pounds to the square inch. This great pressure will be better appreciated if it be stated that it is nearly 40 tons to the running foot of 48-inch main.

‡All work on the aqueduct was suspended in July of 1892 until the 15th of the month, on which date the first official information reached me that temporary provision had been made by Congress on the 30th of June for the expenditures of the Government.

I do not know of any appropriation that more requires to be made available until expended like appropriations for river and harbor improvements, light-houses, etc., than the appropriation for the maintenance and repair of the Washington Aqueduct. I urgently recommend, therefore, that it be done, and that the following clause be attached to the next appropriation for this purpose:

Provided, That the appropriation for the maintenance and repair of the Washington Aqueduct for the fiscal year ending June 30, 1896, and thereafter until otherwise provided by law, shall not be considered as a fiscal year appropriation, but shall be available until expended.

DESIRED INCREASE IN THE ANNUAL APPROPRIATION FOR MAINTENANCE AND REPAIR OF THE AQUEDUCT AND THE RESERVOIRS, MAINS, ROADS, ETC., CONNECTED THEREWITH.

I renew the following statement made in my former reports respecting the importance of increasing the appropriation for maintenance and repair of the aqueduct:

While works that have cost $565,000 have been added to the aqueduct system by the laying of more than 8 miles of 48-inch and other large water mains under the act of March 2, 1889, with their numerous valve chambers, main valves, air valves, blow-off valves, and other adjuncts, all of which have to be carefully watched and kept in repair, there has been no increase in the appropriation for maintenance and repair of the aqueduct.

It has been for many years and is now $20,000, and it proves entirely inadequate for keeping in repair the long line of works, including the dam at Great Falls, the conduit, the Conduit road (which is paved for the protection of the conduit), the reservoirs, the gatehouses, the fences of the aqueduct and Conduit road lands, the dwellings of the watchmen of the different divisions, and the more than 20 miles of trunk mains in the city supplying the distributing system of the District of Columbia, besides paying the salaries of the watchmen and other employés.

Twenty-one thousand dollars was asked for in my last annual estimates, and it is again asked for. It is not a large sum to provide for the annual maintenance and repair of works that have cost more than $4,000,000, and I could expend much more in works of preservation and repair that would be for the best interests of the Government.

Money statements.

WASHINGTON AQUEDUCT.

July 1, 1893, balance unexpended	$805.01	
Amount appropriated by act approved March 3, 1893	20,000.00	
		$20,805.01
June 30, 1894, amount expended during fiscal year		20,267.78
July 1, 1894, balance unexpended		537.23
July 1, 1894, outstanding liabilities		536.82
July 1, 1894, balance available		.41
Amount that can be profitably expended in fiscal year ending June 30, 1896		21,000.00

IMPROVING DALECARLIA RECEIVING RESERVOIR.

Amount appropriated by act approved March 3, 1893	$60,000.00
June 30, 1894, amount expended during fiscal year	58,961.95
July 1, 1894, balance unexpended	1,038.05
July 1, 1894, outstanding liabilities	1,000.95
July 1, 1894, balance available	37.10

ESTIMATES.

The estimates of appropriations that should be made for the year ending June 30, 1896, are as follows, and I again urgently recommend that the provision of law suggested in this report be attached to the next appropriation for maintenance and repair of the aqueduct for the reasons just stated:

For completing the improvement of the Dalecarlia receiving reservoir by the works required for cutting off the drainage into it of polluted water and sewage from the surrounding country; for completing the purchase or condemnation of the small amount of land required for the purpose, and the excavation necessary at the head of the reservoir.. .... $37,500
For raising the height of the dam at Great Falls, together with the cost of such other work as may be found necessary in connection therewith, including the cost of strengthening the conduit, and for damages on account of flooding of land and other damages.................................... 125,000
For commencing the widening of the macadam pavement of the Conduit road to 30 feet by widening that portion of the road that lies between the lower end of the distributing reservoir and the Dalecarlia receiving reservoir; widening the road and the embankments over the culverts on the line of the aqueduct where necessary for this purpose; making the necessary changes in the drainage, and the planting of shade trees............ 34,500
For lowering the height of the cross dam at the distributing reservoir 12,500
For protecting the inlet to the aqueduct at Great Falls 5,000
For purchase or condemnation of a site for a storage yard 10,000
For cleaning out the distributing reservoir................................ 13,825
For the storehouse at Great Falls 1,500
For inserting air valves and blow-off valves in the 36-inch and 30-inch mains. 6,250
For removing the accumulation of deposits in the conduit 14,000
For rebuilding in stone the bridge over the channel from the spillway at the Dalecarlia receiving reservoir 18,000
For raising the height of the masonry casings of the conduit manholes where necessary 600
For maintenance and repair of the aqueduct and the reservoirs, mains, roads, etc., connected therewith 21,000

Appropriations made for the Washington Aqueduct, with the dates of acts for the same.

Date.	Amount.	Date.	Amount.	Date.	Amount.
September 30, 1850...	$500	July 15, 1870 *b*	$120,822	March 3, 1883.......	$20,000
August 31, 1852 *a*....	5,000	March 3, 1871	114,196	July 5, 1884.........	20,000
March 3, 1853........	100,000	June 10, 1872........	70,555	February 25, 1885...	20,000
March 3, 1855........	250,000	January 23, 1873....	14,000	July 9, 1886.........	20,000
August 18, 1856......	250,000	March 3, 1873 *c*......	43,600	March 3, 1887.......	20,000
March 3, 1857........	1,000,000	June 23, 1874 *d*......	36,400	July 18, 1888 *h*	20,000
June 12, 1858.........	800,000	March 3, 1875.......	26,000	March 2, 1889 *i*......	20,000
June 25, 1860.........	500,000	July 31, 1876........	22,000	August 6, 1890 *j*.....	25,500
July 4, 1864..........	150,000	March 3, 1877.......	15,000	March 3, 1891 *k*.....	20,000
July 28, 1866.........	142,584	June 20, 1878	15,000	July 14, 1892........	20,000
December 20, 1866....	12,000	March 3, 1879 *e*......	20,000	March 3, 1893.......	80,000
March 2, 1867........	20,000	June 4, 1880 *f*	20,000		
July 25, 1868.........	52,500	March 3, 1881.......	20,000	Total.........	4,150,657
March 3, 1869........	25,000	July 1, 1882 *g*	20,000		

NOTE.—Reverted to the Treasury: (*a*) $2.81, (*b*) $46.25, (*c*) $560.87, (*d*) 35 cents, (*e*) $1,109.87, (*f*) $381.06, (*g*) $1,354.17, (*h*) $2,266.34, (*i*) $4.12, (*j*) $5,500, (*k*) $2.49; total, $11,228.33. Since 1878 one-half of the amounts appropriated have been contributed by the United States and the other half by the District of Columbia.

ABSTRACT OF PROPOSALS.

Abstract of proposals for drilling plant for the Washington Aqueduct, received in response to advertisement dated June 16, 1893, and opened June 28, 1893.

The Ingersoll-Sergeant Drill Company, New York, N. Y.................. $3,982.30
Contract awarded to the Ingersoll-Sergeant Drill Company.

Abstract of proposals for forcite tunnel powder and exploders for improving the Dalecarlia receiving reservoir, received in response to the advertisement dated July 26, 1893, and opened August 7, 1893.

No.	Name and address of bidder.	Forcite tunnel powder (per pound).					Exploders (per 100).
		40 per cent.	45 per cent.	50 per cent.	60 per cent.	75 per cent.	
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	
1	The American Forcite Powder Manufacturing Co., New York, N. Y. *	16½	17	17½	18½	20½	$4.58
2	T. Joseph Kelly, Baltimore, Md., gelatine powder. †	14	15	16	18	23	3.90
3	G. W. Offutt, Washington, D. C. *	19½	20	20½	21½	23½	4.58

* Rejected as excessive. † Informal. Bid was for a kind of powder not advertised for.

Abstract of proposals for gelatine tunnel dynamite and exploders for improving the Dalecarlia receiving reservoir, received in response to circular letter dated August 11, 1893, and opened August 21, 1893.

No.	Name and address of bidder.	Gelatine tunnel dynamite (per pound). 40 per cent.	45 per cent.	50 per cent.	60 per cent.	75 per cent.	Exploders (per 100).
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	
1	The American Forcite Powder Manufacturing Company, New York, N. Y	11½	12	13	14	16	$3.68
2	Small & Schrader, New York, N. Y	13½	14½	15½	17½	20	3.90
3	Repauno Chemical Company, Wilmington, Del	13½	14½	15½	17½	20	3.90
4	Joseph W. Willard, Cleveland, Ohio*	14	15	16	18	21	4.00

* Not received until the day after the day fixed for opening of bids.

Contract awarded to the American Forcite Powder Manufacturing Company.

Abstract of proposals for sewer bricks and vitrified bricks for improving the Dalecarlia receiving reservoir, received in response to circular letter dated November 29, 1893, and opened December 11, 1893.

No.	Name and address of bidder.	Sewer bricks.	Vitrified bricks.
1	Charles Ford, Washington, D. C	$12.50	
2	Ivy City Brick Company, Washington, D. C	13.50	
3	Frederick Brick Works, Frederick, Md	14.25	$18.50
4	Savage Fire Brick Company, Keystone Junction, Pa		*21.00 †20.00
5	McMahan, Porter & Co., New Cumberland, W. Va		*22.40
6	Potomac Terra Cotta Company, Washington, D. C		†17.50

* Repressed. † Not repressed.

Awards were made to the Frederick Brick Works and McMahan, Porter & Co., respectively, their samples being the best.

Abstract of proposals for natural hydraulic cement for improving the Dalecarlia receiving reservoir, received in response to advertisement dated December 18, 1893, and opened December 28, 1893.

Name and address of bidder.	Natural hydraulic cement per barrel.	Total.
J. G. & J. M. Waters, 1045 Thirty-second street, Washington, D. C.	$1.29, Round Top cement	$5,418
James H. McGill, 908 G street, Washington, D. C.*	$1.17, brand not stated. In subsequent letter this bidder states his brands to be "Cumberland hydraulic" and "Cumberland Potomac" cements.	4,914
Cammack & Decker, First and G streets, Washington, D. C.	$1.22, Cumberland hydraulic cement	5,124
The National Building Supply Company, Baltimore, Md.	$1.33, Cumberland and Potomac cement	5,586

* Brand not stated at time of bid; stated in a subsequent letter.

Contract was awarded to James H. McGill.

B B B 2.

INCREASING THE WATER SUPPLY OF WASHINGTON, DISTRICT OF COLUMBIA.

This work was commenced under an appropriation made in the act of Congress approved July 15, 1882.

The plan consisted in raising the dam in the Maryland Channel at the Great Falls of the Potomac to an elevation of 148 feet above mean

tide at the Washington navy-yard, and its extension at that height across Conns Island and the Virginia Channel of the river; extending the Washington Aqueduct from the distributing reservoir above Georgetown to the site selected for the new reservoir near Howard University by a tunnel 20,696.3 feet long; constructing at the tunnel outlet a new reservoir of about 300,000,000 gallons capacity, and connecting this reservoir by a new line of large mains with the existing system of water mains in the city of Washington.

All operations on this project are suspended, and no work has been done under it during the year.

By reason of the improvement and change of grade of Champlain avenue by the District government, it was found necessary in July to place a timber crib 8 feet high around the Champlain avenue shaft of the tunnel to the new reservoir near Howard University.

On August 28 $470.90 was paid to Thomas Ready for a parcel of land between the distributing reservoir and the intersection of the Conduit and Foxhall roads, conveyed by said Ready and wife to the United States by deed dated March 10, 1886, and the deed and a plot of the land were recorded in the office of the recorder of deeds of the District of Columbia on August 31, 1893. This payment was specially authorized in the provisions for the Washington Aqueduct in the act of Congress approved March 3, 1893.

A watchman has been employed during the year at the new reservoir. His duties have included the guarding the stone at the mouths of all the shafts, except the one at Foundry Branch, which is under the care of the watchman at the distributing reservoir.

The following is a list of the appropriations for this work, with date of act for the same:

July 15, 1882	$1,485,279.30
July 7, 1884	87,500.00
March 3, 1885	87,500.00
March 26, 1886	5,000.00
August 4, 1886	555,000.00
March 30, 1888	355,000.00
Total	2,575,279.30

Money statement.

Title of appropriation.	July 1, 1893, balance unexpended.	June 30, 1894, amount expended during fiscal year.	July 1, 1894, balance unexpended and available.
Land to extend aqueduct	$24,927.74	$472.90	$24,454.84
Extension of aqueduct	272,099.81	163.99	271,935.82
Main connections	1,989.18		1,989.18
Land for reservoir	173.09		173.09
Constructing reservoir and gatehouse	80,607.90	1,069.14	79,538.76
Water rights and land to extend dam at Great Falls	44,882.04		44,882.04
Completion and extension of dam at Great Falls	4,665.52		4,665.52
Aggregate	429,345.28	1,706.03	427,639.25

No estimate for further appropriation is submitted.

B B B 3.

ERECTION OF FISHWAYS AT GREAT FALLS.

Under a ruling concerning the act of July 15, 1882, providing for the construction of these fishways, the Secretary of War decided that the engineer officer in charge should be held responsible only for the proper protection of the aqueduct dam at Great Falls and the disbursement of the funds appropriated, the Commissioner of Fish and Fisheries being responsible under the act for the plans and specifications of the fishways and their execution.

No work has been done on the fishways during the last fiscal year for want of funds. Sections 2, 3, 4, 5, and 6, and a portion of the permanent dam, have been completed. There remains to be constructed the remainder of this dam and section 1.

The Commissioner of Fish and Fisheries is of the opinion that an additional sum of $7,890 will be required to complete the work, and requests that the estimate for it contained in my last annual report be submitted. It was not acted on by Congress, and it is again submitted. His letter to me is as follows:

> I have to request that you include in your estimates for the ensuing fiscal year an item of $7,890 for the completion of the Great Falls fishways. The additional appropriation asked for is made necessary, first, by reason of an increased cost of sections 2 and 3 over and above the estimate; second, by reason of the construction of a permanent deflecting dam which was found essential for the better protection of the fishways, and to obtain control of the water supply to the same; third, for the reason that a sufficiently large amount is included to cover the work of cleaning out the river bed between the fishways, and to construct a tool shed with small office; and lastly, to provide a small fund with which to repair any damage to the fishways from the effects of the spring freshets before the completion of the permanent deflecting dam.

The appropriations for this work to date are as follows:

Act of July 15, 1882	$50,000.00
Act of February 1, 1888	25,000.00
Act of August 5, 1892	15,000.00

Money statement.

July 1, 1893, balance unexpended	$4,501.29
June 30, 1894, amount expended during fiscal year	4,466.34
July 1, 1894, balance unexpended	34.95
July 1, 1894, outstanding liabilities	2.93
July 1, 1894, balance available	32.02
Amount deemed necessary by the Commissioner of Fish and Fisheries for the completion of the work	7,890.00

APPENDIX 1.

CONDITION OF THE WATER DURING THE YEAR.

Condition of water at Great Falls, Dalecarlia receiving reservoir, and distributing reservoir, and height of water over dam at Great Falls for each day in the year

[The height of water on the dam at Great Falls varied during the year from a minimum of 0.5 of a foot (which was the height for four days in the latter part of July and for fifteen days in August) to a maximum of 4.9 feet on May 21.]

Day of month.	July, 1893. Condition of water: Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.	August, 1893. Condition of water: Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.	September, 1893. Condition of water: Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.	October, 1893. Condition of water: Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.
1	33	36	36	.80	36	36	36	.50	2	18	9	1.80	28	36	36	[illegible]
2	36	36	30	.80	36	36	36	.50	2	12	5	1.40	35	36	36	.80
3	36	36	36	80	36	36	36	.50	5	20	4	1.20	36	36	36	.80
4	1	36	36	.80	36	36	36	50	8	24	6	1.10	36	[illegible]	36	80
5	7	36	24	.80	36	36	36	.55	8	33	6	1.10	34	35	36	.80
6	16	36	14	.80	36	36	36	.50	8	36	7	1.00	34	36	36	.80
7	30	36	15	80	36	36	36	.55	7	36	9	90	36	36	36	.80
8	34	36	24	70	36	36	36	.55	8	36	11	90	36	36	36	.80
9	36	36	36	.70	36	36	36	.55	13	36	14	.90	36	36	36	.80
10	20	36	36	80	36	36	36	50	15	36	19	.80	36	36	36	.80
11	22	36	36	70	36	36	36	.50	18	36	31	80	36	30	36	.80
12	11	36	36	.70	36	36	36	50	21	36	33	.80	36	36	36	.80
13	15	36	36	.70	36	36	36	60	19	29	24	.90	36	36	36	.80
14	25	36	36	70	36	36	30	.50	2	30	22	1.40	2	36	36	1.20
15	2	36	30	.70	36	36	36	50	2	36	22	2.00	1	6	28	2.80
16	5	36	27	.80	36	36	36	.50	2	36	14	1.90	1	6	13	3.60
17	1	36	10	70	36	36	36	50	2	36	8	1.60	1	8	8	2.20
18	1	36	5	70	36	36	36	.50	3	36	4	1.50	1	10	6	1.90
19	4	30	3	.70	36	36	36	.50	5	22	6	1.50	2	19	6	1.50
20	8	36	3	70	36	36	36	.60	6	36	9	1.20	3	19	5	1.30
21	20	36	5	70	36	36	36	55	6	25	12	1.10	4	22	7	1.20
22	28	36	6	.60	36	36	36	.60	7	36	12	1.00	6	26	5	[illegible]
23	36	36	12	60	36	36	36	.60	8	36	14	1.00	4	34	5	1.80
24	36	36	19	60	36	36	36	60	10	36	15	1.00	5	36	7	2.30
25	36	36	26	.60	36	36	36	60	20	36	15	.90	3	36	9	2.40
26	36	36	36	60	36	36	36	.60	20	36	17	.90	4	36	10	2.30
27	36	36	36	60	36	36	36	60	24	36	27	.90	6	36	7	1.90
28	36	36	36	.50	36	36	36	60	24	36	32	.90	8	[illegible]	6	1.70
29	36	36	36	50	15	36	36	.65	26	36	36	.80	9	36	7	1.60
20	36	36	36	.50	3	5	36	1.00	27	[illegible]	36	.80	11	36	10	1.40
31	36	36	36	.50	1	15	24	2.20	......	......	......	......	13	36	13	1.40

Day of month.	November, 1893. Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.	December, 1893. Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.	January, 1894. Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.	February, 1894. Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.
1	16	36	15	1.80	3	30	11	1.50	36	34	36	.90	7	28	27	[illegible]
2	22	36	19	1.30	4	27	7	1.60	36	36	[illegible]	.90	8	16	20	1.00
3	25	36	23	1.20	6	30	6	1.40	36	36	36	.90	10	27	13	1.00
4	27	36	29	1.20	3	25	5	1.40	36	36	36	.90	13	20	15	1.00
5	28	36	34	1.10	8	24	5	1.40	36	36	36	.90	10	18	14	1.00
6	3	36	36	1.50	10	28	5	1.40	36	36	[illegible]	.90	10	19	14	1.10
7	2	36	36	2.10	12	24	9	1.30	36	36	36	.90	10	19	22	1.40
8	3	36	14	1.90	16	30	10	1.30	36	36	36	.90	[illegible]	21	21	1.30
9	2	36	9	1.70	20	36	12	1.20	36	36	36	.90	14	22	21	1.30
10	4	36	10	1.50	28	36	17	1.20	36	36	36	.90	7	26	17	1.40
11	8	36	10	1.40	34	36	25	1.20	36	36	36	.90	1	33	23	2.00
12	8	30	12	1.30	36	36	32	1.10	36	36	36	.90	2	25	14	[illegible]
13	20	34	13	1.20	36	36	36	1.10	30	36	36	90	2	23	4	1.90
14	23	34	22	1.20	30	36	36	1.00	36	36	36	90	6	21	6	[illegible]
15	30	31	26	1.20	36	36	36	1.00	36	36	36	.90	8	21	8	1.50
16	12	27	30	1.20	36	36	36	1.00	30	36	36	.90	8	24	6	1.50
17	23	28	31	1.10	10	36	36	1.10	36	36	[illegible]	.90	9	21	10	1.40
18	32	31	36	1.10	21	36	36	1.00	36	36	36	90	19	24	15	1.30
19	34	36	36	1.10	25	10	36	1.00	36	36	36	.90	4	30	15	1.40
20	36	36	36	1.00	20	9	36	1.00	36	36	36	90	2	26	16	1.70
21	36	36	36	1.00	21	11	36	1.10	36	36	36	90	1	26	13	2.20
22	36	36	36	1.00	23	12	36	1.10	36	36	36	.90	2	26	9	2.10
23	36	36	36	1.00	30	15	36	1.00	36	36	36	.90	4	28	6	2.00
24	36	36	36	1.00	25	17	36	1.00	36	36	36	.90	6	24	8	1.90
25	36	36	36	1.00	26	17	36	1.00	36	36	36	90	12	27	6	1.60
26	36	36	36	1.00	32	16	36	1.00	36	36	36	.90	15	30	8	1.70
27	36	36	36	1.00	33	15	36	90	36	36	[illegible]	.90	12	34	8	1.60
28	12	36	36	1.00	34	16	36	90	36	36	36	90	20	36	13	1.40
29	6	36	23	1.30	36	16	36	.90	36	36	36	90	......	......	......	......
30	6	36	28	1.30	36	16	36	.90	20	36	36	1.00	......	......	......	......
31	......	......	......	......	36	20	36	90	6	36	36	1.00	......	......	......	......

Condition of water at Great Falls, Dalecarlia receiving reservoir, and distributing reservoir—Continued.

Day of month.	March, 1894. Condition of water. Great Falls.	March, 1894. Condition of water. Receiving reservoir, south connection.	March, 1894. Condition of water. Distributing reservoir, effluent gatehouse.	March, 1894. Height of water over dam at Great Falls, feet.	April, 1894. Condition of water. Great Falls.	April, 1894. Condition of water. Receiving reservoir, south connection.	April, 1894. Condition of water. Distributing reservoir, effluent gatehouse.	April, 1894. Height of water over dam at Great Falls, feet.	May, 1894. Condition of water. Great Falls.	May, 1894. Condition of water. Receiving reservoir, south connection.	May, 1894. Condition of water. Distributing reservoir, effluent gatehouse.	May, 1894. Height of water over dam at Great Falls, feet.	June, 1894. Condition of water. Great Falls.	June, 1894. Condition of water. Receiving reservoir, south connection.	June, 1894. Condition of water. Distributing reservoir, effluent gatehouse.	June, 1894. Height of water over dam at Great Falls, feet.
1	19	36	30	1.40	25	36	36	1.10	14	36	36	1.20	6	11	8	1.40
2	4	36	33	1.50	36	36	36	1.10	27	36	36	1.20	7	12	8	1.40
3	3	36	30	1.70	36	36	36	1.10	32	36	36	1.20	10	20	8	1.30
4	4	36	21	1.90	36	36	36	1.00	34	36	36	1.20	12	25	10	1.30
5	3	36	17	2.60	36	36	36	1.00	36	36	36	1.20	13	27	13	1.30
6	3	36	12	2.50	36	36	36	1.00	3	36	36	1.20	3	25	16	1.30
7	3	36	10	2.70	36	36	36	1.00	1	12	36	2.60	3	25	24	1.30
8	2	36	7	3.20	36	36	36	1.00	1	12	30	2.00	6	25	21	1.30
9	2	36	5	2.80	36	36	36	1.00	1	12	6	1.70	9	28	15	1.30
10	2	36	5	2.40	36	36	36	1.00	2	12	3	1.40	12	36	22	1.30
11	4	36	5	2.10	8	36	36	1.20	5	13	2	1.30	17	36	26	1.20
12	8	36	6	1.90	6	36	36	1.40	6	18	3	1.20	27	34	28	1.20
13	15	36	8	1.80	4	36	30	1.90	4	30	3	1.20	31	36	30	1.10
14	15	36	14	1.60	4	25	16	2.10	7	36	3	1.10	34	36	36	1.00
15	14	36	14	1.50	2	30	30	2.00	10	30	5	1.10	36	36	36	1.00
16	23	36	20	1.50	4	32	12	1.90	18	36	7	1.00	36	36	36	.90
17	25	36	23	1.40	8	32	8	1.70	13	36	8	1.00	36	36	36	.90
18	28	36	36	1.40	11	34	8	1.60	14	36	9	1.10	36	36	36	.90
19	32	36	36	1.30	14	31	13	1.40	5	36	13	1.10	21	36	36	1.00
20	30	36	36	1.30	19	34	18	1.40	1	32	12	2.10	3	36	36	1.00
21	31	36	36	1.30	2	34	23	1.40	1	3	6	4.90	2	36	30	1.00
22	24	36	36	1.30	2	36	16	1.50	1	6	3	4.40	5	36	17	1.00
23	5	36	29	1.30	4	36	15	1.50	1	8	1	2.90	6	36	18	.90
24	8	36	24	1.30	10	36	10	1.40	2	8	1	2.60	13	36	18	.90
25	8	36	17	1.30	13	36	12	1.30	2	8	2	2.70	24	36	18	.90
26	14	36	22	1.30	15	36	19	1.30	3	8	3	2.30	36	36	23	.90
27	14	36	25	1.30	24	36	20	1.20	4	9	4	2.10	14	36	36	.80
28	14	36	21	1.30	30	36	32	1.20	4	9	4	1.80	33	36	36	.80
29	20	36	10	1.20	27	30	36	1.20	5	9	5	1.70	36	36	36	.80
30	32	36	19	1.10	10	36	36	1.10	4	10	8	1.60	36	36	36	.80
31	33	36	24	1.10	..	......	......	......	4	10	7	1.50	......	......	......	......

Number of days during the fiscal year 1893–'94 on which the water was clear or turbid at the places indicated.

Place.	Clear.	Slightly turbid.	Turbid.	Very turbid.
Great Falls	165	82	18	100
Dalecarlia receiving reservoir	312	25	23	5
Distributing reservoir	213	34	63	55

NOTE.—In determining the condition of the water a metallic tube with glass ends is used. This is filled with water, and the distance at which a ball immersed in the water can be seen from one of the ends is noted. When it can be seen at a distance of from 22 to 36 inches, inclusive, it is considered clear; from 15 to 21 inches, slightly turbid; from 8 to 14 inches turbid, and from 0 to 7 inches very turbid.

APPENDIX 2.

Daily gauge pressures at the office of the Washington Aqueduct at 9 o'clock a. m.

Month.	Inch.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Average.
1893.																																	
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
July	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	37½	37½	37½	38	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	36	36	36	36	36	36	37	36½	36	36	36	36	37	36	36.92
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
August	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	36	36	36	36	36	37	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	35	36	36	36	36	36	36	36	36	36
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
September	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
	48	36	36	37	36	36	35	36	36	36	36	37	37	37	37	37	37	37	36	36	36	36	36	36	36	35	36	36	36	35	35	....	36.13
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
October	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	35	35	35	35	36	36	36	36	35	35	35	36	35	35	36	36	36	36	35	36	36	36	36	36	37	36	36	36	37	37	36	36.77
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
November	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
	48	36	36	36	37	37	37	37	36	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	36	37	36	37	37	....	36.80
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
December	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	37	37	37	37	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	38	37½	37½	36	37	37½	37½	37½	37½	37½	37½	37½	37	37	37	37.34
1894.																																	
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
January	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	37½	37½	37	37	37	37½	37½	37½	37½	37½	37½	37½	37½	37	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37	37	37	37	37	37	37.34
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	....	....	31
February	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	(*)	31	31	....	....	....	31
	48	37	37	37	37½	37	37	37	37½	37½	37½	37½	37½	37½	37½	37½	37	37	37½	37½	37½	37½	37½	37½	37½	37½	37	37	37	....	....	....	37.30
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
March	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	37	37	37½	37½	37½	37	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	38	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37	37½	37.45
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
April	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
	48	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	38	37½	37½	37½	37½	37½	37½	37½	37½	....	37.52
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
May	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37.50
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
June	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
	48	37½	37½	37½	36	37	37	37½	37½	37	37	37	36½	36½	37	37	36½	37½	36	36	36	35	35½	35½	35	35	35	35	35	35	35	....	36.28

* Gauge frozen.

APPENDIX 3.

WATER RIGHTS AT GREAT FALLS.

A bill (S. 1359, Fifty-third Congress, second session) to amend an act approved July fifteenth, eighteen hundred and eighty-two, entitled "An act to increase the water supply of the city of Washington, and for other purposes," as amended and reported from the Senate Committee on the District of Columbia, May 11, 1894, with copies of reports on said bill.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act entitled "An act to increase the water supply of the city of Washington, and for other purposes," approved July fifteenth, eighteen hundred and eighty-two, be so amended as to enable the Attorney-General and the Secretary of War, in the exercise of the authority therein and hereby conferred on them, to obtain title for the United States, by right of eminent domain or otherwise, to all the water rights at and in the vicinity of Great Falls, on the Potomac River, the water so taken to be used for any and all public purposes, and also such land as may be necessary for these purposes. Within nine months after the approval of this act the Secretary of War and the Attorney-General shall make a written statement, specifying by metes and bounds the lands they may deem necessary to take for the purposes of this act, excluding the lands already purchased by the United States and paid for, and shall file triplicate originals of said statement in the offices of the register of deeds for the District of Columbia, the county of Fairfax, Virginia, and the county of Montgomery, Maryland, respectively, and said filing of said statement shall be a taking for the United States by right of eminent domain of the lands and waters specified in said statement and of the water rights appertaining thereto, and shall vest the title to the same absolutely in the United States. If said statement shall include any lands or water rights heretofore taken, or attempted to be taken, under authority of the act to which this is an amendment, or otherwise, and not heretofore paid for, the taking of the same shall be treated as done as aforesaid under this act.

SEC. 2. That if the Secretary of War and the Attorney-General shall agree with any of the owners of the land and water rights taken, or with any of the owners of any lands damaged by said taking, or by maintaining the Government dam at Great Falls at its present height, or by raising the dam to any height that may be deemed necessary for the future supply of the District of Columbia and other public purposes, upon the amount to be paid therefor, they shall give such owner their certificate specifying the sum to which he is entitled.

SEC. 3. That the Secretary of War and the Attorney-General, in their discretion, may appoint three commissioners to appraise the value of the land and of the water and of the water rights taken, and of the damages to any property by reason of the taking, or by reason of maintaining said Government dam at its present height, or by reason of raising the dam to such height as may be necessary for the purpose of this act. In making the valuations the appraisers shall only consider the present values of the land and water rights, without reference to their values for the uses for which they are taken under the provisions of this act. Said appraisement shall be for the guidance and information of the Secretary of War and Attorney-General.

SEC. 4. That any person or corporation owning any lands or water rights or any interest in lands or water rights taken under this act, or who shall be damaged in any way by the taking of the same, or who shall be damaged by reason of the Government dam being maintained at its present height, or by reason of raising the dam to any height that may be deemed necessary for the future supply of the District of Columbia and other public purposes, may within six months after the first publication of the statement provided for in section one of this act, and not afterwards, institute suit against the United States in the Court of Claims by petition setting forth his or its ownership and derivation of title to any land or water rights, or to any interest therein, embraced in said statement, and setting forth any claim he or it may have for damages resulting from said taking, specifying the amount of compensation or of damages claimed, and praying judgment against the United States therefor; and such suit shall be heard, tried, and determined as other suits in said court against the United States: *Provided,* That the United States shall be represented in such suits by special legal counsel conspicuous for known familiarity with and experience in the laws regulating riparian rights and in hydraulics.

SEC. 5. That if any such claimant has a suit now pending in said court for compensation for lands or water rights heretofore taken by the United States at the Great Falls, or for damages resulting from such taking, or resulting from the erection of the Government dam, or from maintaining the same at its present height, such claimant may file in such suit an amended supplementary petition setting forth such additional matters and things as he may deem necessary to have before the

court for the proper adjudication of his entire claims, and such amended supplementary petition having been filed the suit shall embrace all existing claims as well as those that may arise under this act.

SEC. 6. That the Court of Claims is hereby authorized in its discretion to appoint three persons, of whom two shall be skilled in hydraulic engineering, to determine as a board of referee each and all controverted questions of fact, to be formulated and submitted by the court, arising in any suit that may be brought under the authority of this act, or to which it shall apply; and a decision of a majority of them, which shall be rendered within three months from the time of submission unless the court shall extend the time, shall be conclusive on all matters of fact submitted to the board by the court if their award shall be accepted by the court.

SEC. 7. That the judgment rendered in any such suit may be appealed to the Supreme Court of the United States as are appeals from other judgments from said Court of Claims.

SEC. 8. That as said lands, water rights, and waters are taken for the use of the District of Columbia, said judgments and the certificates that may be issued by the Secretary of War and the Attorney-General, provided for in section 2 of this act, together with the costs and expenses incurred by the Secretary of War and the Attorney-General in executing this act, and the fees of the commissioners and the referees and of special counsel and witnesses on behalf of the United States, shall be paid by the Secretary of the Treasury of the United States as judgments rendered by the Court of Claims against the District of Columbia are now paid.

SEC. 9. That persons under disability such as described in section ten hundred and sixty-nine of the Revised Statutes of the United States may bring suit at any time within six months after disability removed.

REPORT.

Mr. Proctor, from the Committee on the District of Columbia, submitted the following report, to accompany S. 1359:

The Committee on the District of Columbia, to whom was referred the bill (S. 1359) to amend an act approved July 15, 1882, entitled, "An act to increase the water supply of the city of Washington, and for other purposes," having carefully considered the same, beg leave to report as follows:

There can be no question of greater importance to the people of any large city than that of securing a sufficient supply of water, pure in quality, and with a reserve in quantity ample for the demands of the future. Here it is not merely a local question, but one of importance to the whole country as well. Washington is the temporary residence of thousands, and is visited annually by millions coming from all parts of the country. The United States owns a large share of the property. The public buildings, parks, and grounds, as a whole, are the finest in the world. The demand for new buildings and other improvements will be frequent and imperative, as the machinery of government must continually and steadily increase with the increase of population of the whole country. Whatever concerns the welfare of this city, therefore, will become more and more of general interest.

The present supply of water is not sufficient in quantity or force for present needs; some action must, therefore, be taken at once. The situation is so fully stated in the able report of Col. Elliot, of the Corps of Engineers, who is now in local charge of the aqueduct and water supply, that little need be said in way of detail. The riparian and water rights at Great Falls are now owned by the Great Falls Manufacturing Company, the Chesapeake and Ohio Canal Company, and the United States. The extent of the Government's present interest is in dispute. The main question presenting itself to the committee is whether to recommend the taking, under the right of eminent domain, of a supply for ordinary purposes sufficient for many years to come, or whether to acquire at once all the rights to the water at that point, settle the existing differences and all danger of future controversies about title, and end forever any danger ot a short supply and the continual trouble and risk of a divided ownership.

If an individual or a business corporation was in the precise situation of the Government, owning a part of the water rights, under the necessity of adding thereto at once, and with the certainty of needing further additions from time to time, there can be no doubt that the party would seek, as a matter of prudence and common business foresight, to acquire the entire water right before extensive improvements were made by the other owners which would greatly enhance the cost. And in this case what would be good policy for an individual or private corporation would be the more so for the Government by reason of the certainty of continuing and increasing requirements. The supply, to be sure, is much larger than will be needed for aqueduct purposes, so far as can be foreseen, but even for this purpose alone your committee believe that it would be wise to control it all.

But there is another point worthy of consideration, and that is the rapidly increasing tendency toward municipal control of certain matters of public necessity and convenience in which the entire people, all classes and conditions, have substantially an equal interest. In our early history turnpikes, owned by private corporations, were common; toll bridges the rule, and towns and cities often obtained their water supply from private companies. Now, turnpikes and toll bridges are relics of the past; the water supply in large towns is almost without exception now furnished by the municipality, and street lighting by the city is already being considered and adopted to quite an extent. Whether it is not feasible and economical for cities to generate and supply by electricity heat as well as light, is a question already mooted. If generally adopted within twenty-five years it would be no stranger than the progress of the last quarter of a century. But laying this possibility aside, the matter of lighting is a present issue, and one of greater importance in this city than in any other on account of the large number of buildings to be lighted at public expense.

Already several measures providing for Government ownership of a lighting plant have been proposed.

All the area of more than 100 feet elevation above low water at the navy-yard is now supplied by pumping, and for want of sufficient pressure all above 75 feet will probably soon require it. The line of 100 feet elevation runs in the vicinity of Florida avenue, and of 75 feet in the vicinity of Massachusetts avenue, west of Eleventh street. The time can not be far distant when a large majority of the residences will be elevated above this line. The vicinity of Tenallytown has an elevation of more than 400 feet above low tide. The pumping is now done at the pump house on U street, between Sixteenth and Seventeenth, at a large expense, and this expense will be constantly increasing as higher lands about the city are built up and higher buildings constructed. It might be done with great saving for the future by electricity generated by the water power at Great Falls.

If the entire power at Great Falls is acquired, we believe it will be ample for electric lighting and pumping purposes for the city. The Great Falls Power Company have very recently obtained new charters from the legislatures of Virginia and Maryland. Their purpose is evidently to develop the power and supply it directly, or through other companies, to the city for lighting and other purposes.

There are no improvements now at Great Falls, except the aqueduct dam, built and owned by the United States. If the Government is ever to acquire control it should be done before any outlay is made by the other owners. Such outlay must be to them a questionable investment, in view of the fact that the Government is sure to require an increased supply from time to time in the future, thus endangering the business of the power company and destroying or greatly lessening the value of their improvements, with the risk that they may not be sufficiently recompensed. Your committee are, therefore, of the opinion that all the water and riparian rights at Great Falls necessary for the control and use of the entire power should be acquired at this time; that it will be a wise economy to do so; that ownership in part by the United States and in part by private business corporations is a relation unwise and unsafe for the Government, and should be terminated at once; that the other owners can afford to surrender their rights now on much better terms for the Government than after they have made their improvements, and that no outlay of money can contribute more than this to the future welfare of the capital of the country.

OFFICE OF THE CHIEF OF ENGINEERS, U. S. ARMY,
Washington, D. C., March 24, 1894.

SIR: I have the honor to return herewith S. 1359 (Fifty-third Congress, second session), "A bill to amend an act approved July 15, 1882, entitled 'An act to increase the water supply of the city of Washington, and for other purposes,'" with letter of the Committee on the District of Columbia, U. S. Senate, of March 9, 1894, and other papers referred to this office therewith.

Attention is invited to the remarks herewith of Col. G. H. Elliot, Corps of Engineers, in immediate charge of the Washington Aqueduct, and to the amendments of the bill recommended by that officer. Certain of these amendments are indicated in Copy A of the bill, herewith.

But Col. Elliot states that it is not apparent that the bill thus amended, having become a law, would authorize the use by the United States of water, acquired under the bill, for actuating hydraulic machinery (turbines) located below the falls, and also suggests additional amendments looking to the taking of all of the water flowing at Great Falls. These additional amendments are indicated on Copy B of the bill, herewith.

I concur in the recommendation that the bill be amended as indicated on Copy B, and further recommend that, if the bill is to become a law, it shall be so worded as

to enable the United States not only to acquire title to all lands and water rights at and in the vicinity of the Great Falls, but also to use the water so taken to actuate machinery located anywhere, in connection with the public service of the District of Columbia.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brigadier-General, Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

OFFICE OF THE WASHINGTON AQUEDUCT,
Washington, D. C., March 20, 1894.

GENERAL: In respect of bill S. 1359, Fifty-third Congress, second session. "A bill to amend an act approved July 15, 1882, entitled An act to increase the water supply of the city of Washington, and for other purposes," which you sent me on the 9th instant for report (E. D. 5250–1894), I beg to state as follows:

The bill, it will have been observed was introduced into the Senate "by request." It relates exclusively to land and water rights at Great Falls, and, while it is in most respects an excellent bill, there are certain amendments that should be made in the interests of the United States and the District of Columbia, which is required to pay one-half of whatever sums are to be expended for the purchase of these land and water rights.

The act of July 15, 1882, provided, among other things, for the acquisition by condemnation of the outstanding title, if any, to the land necessary for a dam across the Potomac River at Great Falls, including the land then occupied by the dam, the land required for the extension of the dam across Conns Island to and upon the Virginia shore and the land on which the gatehouse stands. The act provided also for the acquisition of certain unspecified water rights, and contained an appropriation of $45,000 to pay for all of these lands (except the land occupied by the gatehouse, which was not provided for), and for the water rights in the following item:

"To pay for water rights and land necessary to extend dam at Great Falls to the Virginia shore, forty-five thousand dollars."

The act also contained the following item:

"For work and material to complete the dam at Great Falls to the level of one hundred and forty-eight feet above tide, and extend the same to the Virginia shore, one hundred and forty-five thousand one hundred and fifty-one dollars."

The proceedings to be had in condemnation were prescribed as follows:

"When the map and survey are completed, the Attorney-General shall proceed to ascertain the owners or claimants of the premises embraced in the survey, and shall cause to be published, for the space of thirty days, in one or more of the daily newspapers published in the District of Columbia, a description of the entire tract or tracts of land embraced in the survey, with a notice that the same has been taken for the uses mentioned in this act, and notifying all claimants to any portion of said premises to file, within its period of publication, in the Department of Justice, a description of the tract or parcel claimed, and a statement of its value as estimated by the claimant. On application of the Attorney-General, the chief justice of the supreme court of the District of Columbia shall appoint three persons, not in the employ of the Government or related to the claimants, to act as appraisers, whose duty it shall be, upon receiving from the Attorney-General a description of any tract or parcel, the ownership of which is claimed separately, to fairly and justly value the same and report such valuation to the Attorney-General, who thereupon shall upon being satisfied as to the title of the same, cause to be offered to the owner or owners the amount fixed by the appraisers as the value thereof; and if the offer be accepted then upon the execution of a deed to the United States in form satisfactory to the Attorney-General, the Secretary of War shall pay the amount to such owner or owners from the appropriation made therefor in this act.

"In making the valuation the appraisers shall only consider the present value of the land without reference to its value for the uses for which it is taken under the provisions of this act.

"The appraisers shall each receive for their services five dollars for each day's actual service in making the said appraisements.

"Any person or corporation having any estate or interest in any of the lands embraced in said survey and map who shall for any reason not have been tendered payment therefor as above provided or who shall have declined to accept the amount tendered therefor, and any person who, by reason of the taking of said land, or by the construction of the works hereinafter directed to be constructed, shall be directly injured in any property right, may, at any time within one year from the

publication of notice by the Attorney-General as above provided, file a petition in the Court of Claims of the United States setting forth his right or title and the amount claimed by him as damage for the property taken or injury sustained; and the said court shall hear and adjudicate such claims in the same manner as other claims against the United States are now by law directed to be heard and adjudicated therein: *Provided*, That the court shall make such special rules in respect to such cases as shall secure their hearing and adjudication with the least possible delay."

The act also contained the following requirements:

"Judgment in favor of such claimants shall be paid as other judgments of said court are now directed to be paid; and any claimant to whom a tender shall have been made as hereinbefore authorized and who shall have declined to accept the same, shall, unless he recover an amount greater than that so tendered, be taxed with the entire cost of the proceeding. All claims for value or damages on account of ownership of any interest in said premises, or on account of injury to a property right by the construction of said works, shall, unless a petition for the recovery thereof be filed within one year from the date of the first publication of notice by the Attorney-General as above directed, be forever barred: *Provided*, That owners or claimants laboring under any of the disabilities defined in the statute of limitations of the District of Columbia may file a petition at any time within one year from the removal of the disability.

"Upon the publication of the notice as above directed, the Secretary of War may take possession of the premises embraced in the survey and map, and proceed with the constructions herein authorized; and upon payment being made therefor, or without payment, upon the expiration of the times above limited without the filing of a petition, an absolute title to the premises shall vest in the United States."

The dam was extended and completed as specified in the years 1881–'83 at a cost of about $140,000.

I was not placed in charge of the aqueduct till several years afterwards, but it can be stated that neither the land occupied by the dam, which was taken by the right of eminent domain, nor the water rights have been paid for.

The following claims for the land and water rights taken and the damages resulting from the taking were filed:

The Chesapeake and Ohio Canal Company, by Lewis C. Smith, president, a claim for $600,900.

The Great Falls Manufacturing Company, by Benjamin F. Butler, president.

The claims of this company were stated in the following terms:

"If the condemnation be for all of its water rights, the company estimates its damage at $1,000,900 and claims this amount.

"If the condemnation be for one-half of said rights, then the company claims $500,000.

"If the United States shall consent to let the company draw from the dam the surplus and unused water and shall provide the means for such drawing, a further reduction of the claim will be made."

I send herewith a plat explanatory of this report, in which I shall endeavor to draw attention to the great importance of a careful and cautious consideration of the bill.

The plat shows Conns Island, the Maryland and Virginia channels separated by it, and the site of the dam, about 3,000 feet long, as it now exists, extending from shore to shore of the river.

The dam as it was at the date of the passage of the act extended out from the Maryland shore of the river above the falls and below the intake of the Washington Aqueduct, across the Maryland channel to the shore of Conns Island, and was 1,034 feet long. The necessity of the extension of the dam provided for in the act arose from the fact that by reason of its narrow width, shallow depth, and its obstructions, the Maryland channel was found to be inadequate to furnish to the aqueduct all the water required to meet the increasing demands upon it.

The land taken under the act mainly consisted of a narrow strip extending from the *medium filum aquae* of the Virginia channel to the western shore of Conns Island; thence across Conns Island to the eastern shore; thence to the *medium filum aquae* of the Maryland channel. The strip did not extend from the *medium filum aquae* of the Virginia channel to the Virginia shore for the reason (see the plat) that the United States was already, from 1854, a riparian owner at the Virginia end of the proposed extension of dam.

There was also included in the taking a small triangular portion of the bed of the Virginia channel between the *medium filum aquae* of the channel and the Virginia shore that was not covered by the riparian right of the United States as an owner on that shore, the lot on which the gate house stands, and also the land on the Maryland shore below this lot, extending to the shore, and covering in addition that part of

the river-bed site of the Maryland end of the old dam that was not already the property of the United States.

The area of the land taken is in all about 21 acres. Of this about 8¾ acres are on Conns Island; about 2¼ acres are on the Maryland shore; about 7 acres are on the bed of the Potomac, in the Virginia channel, and about 2¾ acres are on the bed of the Potomac, in the Maryland channel—in other words, about one-half of the entire area is covered by water.

Great Falls is a series of rapids in the river, extending about one-half or three-fourths of a mile, in the course of which the river falls about 70 feet. It is about 16 miles above Washington. The eastern shore of the river is in Montgomery County, Md., and the jurisdiction of Maryland extends to the western shore, which is in Fairfax County, Va. The three principal owners of the lands adjacent to Great Falls are the Great Falls Manufacturing Company, the Chesapeake and Ohio Canal Company, and the United States. A fairly good estimate may be formed of the extent of their respective ownerships by an inspection of the plat and comparing the lengths of the mainland and island shores owned by them.

The only existing improvement of water rights at the falls is the aqueduct dam built by the United States.

Conns island is above the falls proper. It is about 3,500 feet long, about 1,000 feet wide at the widest place, and about 670 feet wide at the place near the foot of the island where it is crossed by the extension of the aqueduct dam. Its axis is about parallel with the thread of the current of the river, which at the falls runs about due south. The island is low and, where it is crossed by the extension of the dam, rocky. It is cut up by numerous channels, and the major part of the entire island is, during ordinary spring freshets, overflowed by the river.

The island is unimproved and uninhabited. The land is of but little value, if any. As a riparian owner, the Great Falls Manufacturing Company claims an interest in the water that flows both in the Maryland and Virginia channels, and it is this ownership that has been the basis of litigation and of claims against the United States for thirty years. The United States is a riparian owner opposite Conns Island both on the Virginia and Maryland shores, and if the assumption that the proportion of right of control of the water flowing in an unnavigable channel, held by each of two opposite riparian owners, does not depend on the relative lengths of their shore lines be correct, then it would appear that the United States has as much of the right of control of the water flowing on each side of Conns Island as have the owners of the island.

Land on the Maryland shore at Great Falls may be worth $200 an acre, but not more. I am told that land on the Virginia shore is worth from $20 to $30 an acre.

I invite attention to the following important points in the act of July 15, 1882, and in Senate bill 1359.

(1) The amount authorized by Congress to be expended under the act is, for land and water rights at Great Falls, limited to $45,000.

The amount that, for the same object, may be expended under the provisions of the bill if enacted in its present form, and if the prices for the land and the water rights can be agreed on with the owners, is apparently unlimited. In the cases where there be no agreement the owners may institute suits in the Court of Claims, and the judgments of the court are apparently to be paid without limit by the Treasury Department.

(2) The act contains the following provision:

"In making the valuation the apppaisers shall only consider the present value of the land without reference to its value for the uses for which it is taken under the provisions of this act."

There is no such provision in the bill, but for the reason that the value of its water supply to Washington or any increase thereof is inestimable, there being no standard of values that can properly be applied to it, I think it important that a provision similar to the foregoing should be applied to the water rights as well as the land at Great Falls to be taken under the terms of the bill.

(3) The bill requires that the land and water rights at Great Falls are to be taken to the extent that may be deemed "necessary for the present and future supply of said District of Columbia, the water so taken to be used for any and all purposes." This is not contained in the act which the bill proposes to amend. The present supply to the city is about 45,000,000 gallons per diem. If provision is to be made for future supply, either in this bill or elsewhere, the amount should, I think, be stated at 200,000,000 gallons per diem. This, for the reason that from computations that I made after the last census of Washington (1890), I found the supply per diem per capita to be about 200 gallons, and I am of the opinion that if we are now to make arrangements for all time provision should be made for not less than 1,000,000 inhabitants.

(4) The bill provides (section 2) that in cases of agreement with the owners as to the prices of land and water rights taken, and where there be disagreements in cases

of judgments rendered by the Court of Claims, the officials specified in the bill "shall have authority to enter into contracts with the owners of the land adjacent to the Great Falls, respectively, to secure to the latter the right to use, and facilities for using, so much of the water of the Potomac as may not be taken as aforesaid and used by the United States. And to this end they may authorize or permit such structures to be made as may be necessary and the value of any rights thus granted shall be received in part payment of the land and water rights taken as aforesaid."

There is nothing referring to these contracts in the act, and it is difficult to understand the full meaning and intention of this provision. Whatever they may be, it seems to be clear that the bill contemplates that the United States shall secure to the owners of land at Great Falls the facilities for using, as well as the right to use, all of the flow of the Potomac that may not be taken and used by the United States.

Let us suppose, for instance, that the United States, for itself and the District of Columbia, "takes" under the provisions of the bill, that is to say, acquires by an exercise of the right of eminent domain the right to take 200,000,000 gallons of water per diem. The quantity that may be "taken and used" is different. It is the quantity sent down and to be sent down to Washington through the aqueduct and future additions to the aqueduct. It will increase from year to year, and the bill contemplates such increase without additional compensation to the owners of the land and water rights, up to the limit of the quantity "taken."

I can best explain the point I wish to make, in respect of this part of the bill, by figures.

In a suit against the United States for damages in the sum of $500,000 by the Great Falls Manufacturing Company, as owners of Conns Island (in which judgment was rendered in 1879 against the United States for $15,692), it was agreed on by counsel, and accepted by the court, that the low-water flow of the Potomac should be stated at 1,065 cubic feet per second, say 700,000,000 gallons per diem. Excluding the times of freshets, the average flow may be said to be at least 6,500,000,000 gallons per diem. In times of very high water and freshets it is much greater, and in the flood of 1889 it was at the rate probably of not less than 305,650,000,000 gallons per diem. *

Assuming, for illustration, that the quantity of water now "taken and used" by the United States is, say, 45,000,000 gallons per diem, and that the quantity to be "taken" under the provisions of the bill be 200,000,000 gallons per diem, the bill would require that the United States shall secure to the owners of the lands adjacent to the falls the facilities for using (and also the right to use) the following quantities of water per diem:

During low-water flow, say, 655,000,000 gallons now, decreasing to 500,000,000 gallons when the limit of the quantity "taken," say, 200,000,000 gallons per diem, shall be reached.

During average flow (excluding freshets), say, 6,455,000,000 gallons now, decreasing to 6,300,000,000 gallons when the above-mentioned limit shall be reached.

To these quantities should be added the constantly varying (decreasing) difference between the quantity of water "taken" and the quantity of water "used," the latter quantity, as said before, being at this time, say, 45,000,000 gallons per diem.

To "secure" to the owners of the land and water rights at Great Falls the facilities for using the remainder of the flow of the Potomac (whether this remainder be, as it would be, more than two-thirds of the low-water flow and about 97 per cent of the average flow), may mean either to provide these facilities and keep them in repair † or to make the facilities certain.

The explanatory words "authorize and permit" in the next sentence seem to preclude the first of these meanings; but if it should be held to be the true one, the United States would either be obliged to make a cut or cuts in the aqueduct dam through which this remainder could be drawn, or to construct a dam below the aqueduct dam to collect, and from behind which could be transmitted to the manufactories and other works below the falls the water flowing over the aqueduct dam. The first of these would be inadmissible, for the reason that any cut or cuts in the

* Prof. Babb, American Society Civil Engineers, of the Geological Survey, in a paper on the Hydrography of the Potomac Basin (1891), gives the following averages of flow of the Potomac at Great Falls. His statements are in cubic feet, and I have reduced them to gallons:

Average flow of the Potomac at Great Falls, in gallons per diem.

1886	8,107,128,000	1889	21,327,624,000
1887	7,698,240,000	1890	13,846,464,000
1888	9,956,020,000	1891	17,449,344,000

† In the claim of the Great Falls Manufacturing Company (see *ante*) are the following words: "If the United States * * * shall provide the means for such drawing."

aqueduct dam would impair and make irregular the supply to the city through the aqueduct. To construct across the Virginia Channel a dam below the aqueduct dam would cost, say, $150,000.

The second supposed meaning being adjudged the true one, the word "secure" would simply have reference to the manner of drawing up the contract referred to in the section.

The closing words of section 2, viz, "and the value of any rights thus granted" to the owners of the land and water rights "shall be received in part payment of land and water rights taken as aforesaid," are difficult to understand. It requires a quantity to be deducted from another quantity less than itself.

The value to each of the owners of the water rights at Great Falls is the value of his share of the water of the river flowing at that point, and may be stated at a rate per 1,000,000 gallons per diem. The share may be used by its owner for a supply for domestic purposes, or for power, or for both, or he may sell it. The value of the land, apart from the value of the water rights, is its value for sites of manufactories below the falls; for sites of dwellings for workmen and others, and for the location of canals leading from the head of the falls to the works.

In the case supposed, the United States "takes" under the operation of section 1 of the bill, that is, secures a right to take, a water supply for a population of 1,000,000 inhabitants, say, 200,000,000 gallons per diem. This is the "water right taken." The United States also "takes" about 21 acres of land, about one-half of it being in the bed of the Potomac and the other half being a rocky and uncultivable strip across Conns Island. This is the "land taken."

The words "rights thus granted," near the end of section 2, refer to the right to be secured to the owners of the land by the United States of using, as has just been explained, the remainder of the flow of the Potomac, say two-thirds of the low-water flow and about 97 per cent of the average flow. The value of the water per 1,000,000 gallons per diem (whether it be the water to be taken by the United States, or the remainder to be secured to two of the owners of the falls—the third owner being the United States) should be same in each case, but in section 2 it is said "the value of any rights thus granted shall be received in part payment of the land and water rights taken." The value of the water "rights thus granted," is immensely superior to the value of the "water right taken," as may be seen by comparing the quantity of water "granted" with the quantity of water "taken," and the difficulty of understanding what is intended by requiring that the value of the former shall be received in part payment of the latter is not explained by the fact that in addition to the "water rights taken" there was "land taken," for, being above the falls, the land is not valuable for any of the purposes just mentioned, and apart from its water rights it is certainly not worth more than $1,000.

If, under the terms of the bill, all of the water rights at Great Falls, that is to say, the entire flow of the Potomac, could be "taken" by the United States—provision being made that all the water not required by the United States should be "granted" back to the owners of the water rights—the intention of section 2 would be apparent, but the bill gives authority to "take" only the quantity of water deemed necessary for the present and future supply of the District of Columbia, say 200,000,000 gallons per diem. The intention of the section would also be apparent if it should, in the opinion of the drawer of the bill, have been considered that the value per 1,000,000 gallons of the water to be "granted" back and secured to the owners of the land is exceedingly small as compared with the value per 1,000,000 gallons of the water to be "taken" by the United States.

If, as might be inferred from the bill, the coowners with the United States actually own all the remainder of the water that is not drawn from the river by the aqueduct, I do not see the necessity or, as there is a question as to this ownership, the propriety of confirming it by contracts. I think, therefore, that all of section 2 after the word "entitled" in line 7 and all of section 3 comprised between and including the word "and" in line 6 and the word "States" in line 9 should be stricken out of the bill.

(5) It will have been observed that provision was made in the act of 1882 and provision is made in this bill for the ascertainment and payment of damages. The damages referred to are damages to water rights; that is, the diversion of water from the river above the falls through the aqueduct to Washington. This is evidenced by the claims filed under the provisions of the act and by previous claims and by the suit of the Great Falls Manufacturing Company against the United States, to which reference has already been made. That caution should be observed in the consideration of what the bill contains respecting these damages is made manifest:

(A) By comparing the magnitude of the extravagant claims for damages already filed with the very small proportion of the water now diverted and of the water that can under the terms of the bill be diverted to Washington as compared with the total flow of the river, and by comparing also the amount of these claims with the amount ($45,000) that Congress in its act of 1882 deemed sufficient to pay for all the land and water rights at Great Falls that were to be taken under the act.

(B) By an inspection of the plat entitled "Great Falls of the Potomac and Vicinity," which accompanies this report, it will be seen that, thanks to the wise foresight, about forty years ago, of the late Gen. Meigs, the United States is owner of a tract (of about 6 acres) at the Virginia end of the dam; that it is owner of a tract (of about 20 acres) called "Resurvey of Hard to come at;" that it is half owner of a tract (of about 99 acres) called "Resurvey on Hard to come at;" including Falls Island, and that it is owner of a lot (of about 5½ acres) on which stands the watchman gatekeeper's house, being a part of a tract called Goose Pond.

The total area of these lands is about 130½ acres, and their cost to the United States, including the cost of the water rights belonging to them, was $3,720.

It is also owner of the right (conferred by the decision in 1879 in the case of the suit of the Great Falls Manufacturing Company against the United States) of maintaining the dam across the Maryland channel at its present height of 148 feet above the height of low tide at the navy-yard at Washington.

As the purchases of the land mentioned carried with them all the water rights belonging to them, it would appear, and I have no doubt, although it has so far as I can discover not heretofore been stated or asserted, that the United States is of right entitled to more than one-third of all the water rights at Great Falls, and is therefore entitled to more than one-third of all the water flowing there. For the reason that the 45,000,000 gallons per diem now diverted from the river for the supply of Washington is, as has been before stated, but a small fraction of this proportional part of the water, and for the reason that even if there should be diverted the 200,000,000 gallons per diem required for a population of 1,000,000 of inhabitants, this proportional part would still not be nearly reached. I think it extremely doubtful if in respect of their water rights the other owners of land adjacent to the falls have ever been, or will ever be, damaged by the United States by the withdrawal from the river of the water supply of Washington.

(C) I find in the brief of special counsel for the United States in the suit of the Great Falls Manufacturing Company against the United States for damages to water rights of the former by the construction of the dam across the Maryland channel, which suit was decided in 1879, the following important statement respecting the Toulson tract owned by the Great Falls Manufacturing Company:

"While we do not think the Toulson tract and the riparian rights appurtenant thereto have been invaded by the United States, and contend that they are not entitled to consideration in the present case, we deem it proper, in view of the effect which the ascertainment of those rights by the court might have upon a future extension of the dam, to state distinctly our position.

"(1) The court of appeals of Maryland, in a proceeding between the parties to the present suit, held that the State of Maryland, by legislative grant, had conferred, in 1853, upon the United States the soil between the Virginia low-water mark and the *medium filum aquæ* extending from a point above to a point below the falls (21 Md. Rep., p. 119, and pp. 375, 376, 377, record; Baltimore *v.* McKim, 3 Bl., 453).

"The riparian right appurtenant to the Toulson tract has thus become *res judicata*.

"(2) The court of Maryland had jurisdiction of the *res* because it was included within the grant to Lord Baltimore in 1632 (*see* Bacon's laws of Maryland, vol. —, p. —); and because, further, no act of Maryland has ever ceded this jurisdiction, and there is nothing to show that Virginia ever claimed it."

If my inference drawn from this statement be the true one, then the Great Falls Manufacturing Company, apart from the rights conferred by its ownership of Conns Island above the falls, has no interest in the water rights (water) at Great Falls, and the Chesapeake and Ohio Canal Company's land being cut off from the main channel of the river by the interposing land of the United States bordering on this channel, called "Hard to come at," the United States owns of right by far the greater part of all the water rights at the falls. Without regard to its water rights the Toulson tract is, however, the most valuable land at the falls, it containing, as before stated, the best site for manufactories and other works below the falls, and also the remains of the old Potomac Canal constructed by Gen. Washington in 1785, which is the best, if not the only, location practicable for a canal from the head of the falls to these sites.

For the reason that the two coowners with the United States at Great Falls will no doubt employ, in the trials of the suits for damages that are to be had in the Court of Claims in case of failure of the United States to agree with these owners as to values, lawyers skilled in such cases, I think it most important that the sixth section of the bill be so amended as to authorize and direct the employment by the United States in these suits of special legal counsel conspicuous for known familiarity with and experience in the laws regulating riparian rights and in hydraulics. The eighth section of the bill, also, should be so amended as to provide for payment of this counsel and of witnesses on behalf of the Government. * * *

The amendments that I have suggested, and a few others, the objects of which will be apparent, would, I believe, thoroughly guard the interests of the United States

and the District of Columbia, and, for the reasons that follow, I think it of very great importance that, as amended, the bill be passed as soon as possible. The legislation provided for in the bill as amended, is, in my estimation, more important than any other that has been enacted since the construction of the aqueduct.

(1) The decision of the Court of Claims of 1879 having been mainly in respect of the damage to the owners of Conn's Island by reason of the abutting on that island of the dam across the Maryland channel (or rather by reason of an agreement as to this damage in 1862 between the Secretary of the Interior and the Great Falls Manufacturing Company, which the United States, in the suit decided in 1879, claimed to have been illegal), there has not been since the extension of the dam to the Virginia shore, nor at any time, a judicial decision of the extent of the rights of the United States at Great Falls, and this bill furnishes an opportunity for such decision. When the decision has been made, it would operate for all time, and, when future additions to the Washington water supply have to be made from time to time, as the population increases, the required quantities can be taken from the river without further action of the courts and without further legislation of Congress, except the making of the appropriations necessary for raising the dam and other works, if any, required for these additions.

(2) The lands at Great Falls taken by the United States from the Great Falls Manufacturing Company under the operation of and by direction of the act of July, 1882, and several small parcels of land taken, also without payment, from the Chesapeake and Ohio Canal Company, a portion under the operation of the act of July 15, 1882, and the remainder at previous times, have never been paid for.

The lands taken from the Chesapeake and Ohio Canal Company are: The lot at Great Falls on which stands the gatehouse that regulates the supply of water through the aqueduct to Washington; the land extending from this lot to the Maryland bank of the river, including the right to pass the aqueduct under the canal; the land under which is the upper portion of tunnel No. 1, and the land occupied by the aqueduct between the gatehouse and the head of this tunnel; a parcel of land in Montgomery County, Md., occupied by a portion of the aqueduct, and a parcel of land in the District of Columbia occupied by the mains leading from the distributing reservoir to the city.

I am told that the charters of the Chesapeake and Ohio Canal Company, derived from the United States and from Maryland, provide that no adverse possession shall hold against any of its properties. If this be the case, an application of the statute of limitations, even if it should be deemed proper and advisable, could not be made to operate against these lands, some of which have been occupied by the works of the Washington Aqueduct for nearly forty years, and the bill should be so amended as to include these lands, to the end that their values may be judicially and fairly determined and paid to the owners.

(3) The question of what are the rights of the United States at Great Falls, how much of the water of the river it is entitled to, should be settled. The language of the bill seems to imply that these rights are very small in comparison with other rights; that the drawing for the Washington supply of the small quantity of water heretofore used and now used (that is to say, small in comparison with future wants) has been and is an infringement on the rights of others, and that damage has been done to others. If this be the case, the facts should be known before any new obligations are created. The time has now come when the water supply of Washington must be increased. It is imperative that the present dam at Great Falls be raised throughout its entire length as soon as an appropriation can be obtained for this purpose, and it is my intention to submit an estimate for the work in my next annual estimates. The necessity for this arises from the fact that in summer during the low stages of the river I find it impossible to keep the distributing reservoir up to the height of 146 feet above datum, which is required for the full service of the mains leading from the reservoir to the city. During these low stages of the river the aqueduct at its intake lacks, in respect of its height, about 2½ feet of being full, and the dam must be raised accordingly. If the dam be raised 2½ feet, not only would the aqueduct never fail to run full, but, the "head" of water being raised at the intake, the velocity through the aqueduct would be very much increased. If the bill be passed before raising the dam, the right of the United States to draw the additional quantity of water from Great Falls will have been obtained by the exercise of the right of eminent domain, provided for in the bill, and the work can go on without delay. Otherwise the work may be enjoined in the Maryland court and have to be suspended until the legal questions be decided.

(4) It is desirable that all existing contentions and claims against the United States be settled judicially and fairly in the manner proposed in the bill as amended.

The amendments that I would propose are as follows, and they will be found in the copy of the bill herewith, marked A:

In section 1, line 13, insert after the word "all" the word "public," and in the same line strike out the words "ninety days" and insert the words "six months," and in line 30 insert after the word "amendment" the words "or otherwise."

In section 2 insert after the word "height" in line 5 the words "or by raising the dam to such height as may be necessary for the purpose of this act," and strike out all of the section after the word "entitled" in line 7.

In section 3, after the word "height" in line 6, insert the words "or by reason of raising the dam to such height as may be necessary for the purpose of this act. In making the valuations the appraisers shall only consider the present values of the land and water rights, without reference to their values for the uses for which they are taken under the provisions of this act." And strike out all of the words from and including the word "and" in line 6 to and including the word "States" in line 9.

In section 4, after the word "height" in line 6, insert the words "or by reason of raising the dam to such height as may be necessary for the purpose of this act," and after the word "States" in line 17 add the words "*Provided*, That the United States shall be represented in such suits by special legal counsel conspicuous for known familiarity with and experience in the laws regulating riparian rights and in hydraulics."

In section 6, lines 2 and 3, strike out the words "one or more" and insert the word "two."

In section 8, line 7, after the word "referees," insert the words "and of special counsel and witnesses on behalf of the United States."

It will have been observed that the water to be "taken" under the provisions of the bill is strictly for the supply of the District of Columbia, and that the words "the water so taken to be used for any and all purposes," in the twelfth and thirteenth lines of section 1, refer to use of the water in the District of Columbia. It is not apparent that should the bill become a law the use of Potomac water would be extended to purposes other than the purposes of its present use, viz, domestic supply, supply of the public buildings, street washings, and hydraulic power in the District of Columbia. The use for hydraulic power in the District of Columbia must be very limited by reason of the capacity of the aqueduct and of any probable addition to the aqueduct. Should it be desired to use turbines below the falls to operate electric generators for transmitting electric power to Washington and lighting the public buildings, no portion of the water to be acquired under the bill could be used for these turbines. If Congress would authorize the taking, under the operation of the provisions of the bill, of all the water flowing at Great Falls, there would not only be no limit to the quantity of water available for supply to the District, but there would doubtless be an abundance of water remaining for hydraulic machinery (turbines) below the falls, sufficient to operate a number of electric generators adequate not only for the lighting of the Capitol and all the other public buildings, the lighting of all of our streets, and possibly for the working of machinery for the raising of water to the rapidly increasing portion of the District that is above the area that can be supplied by gravity.

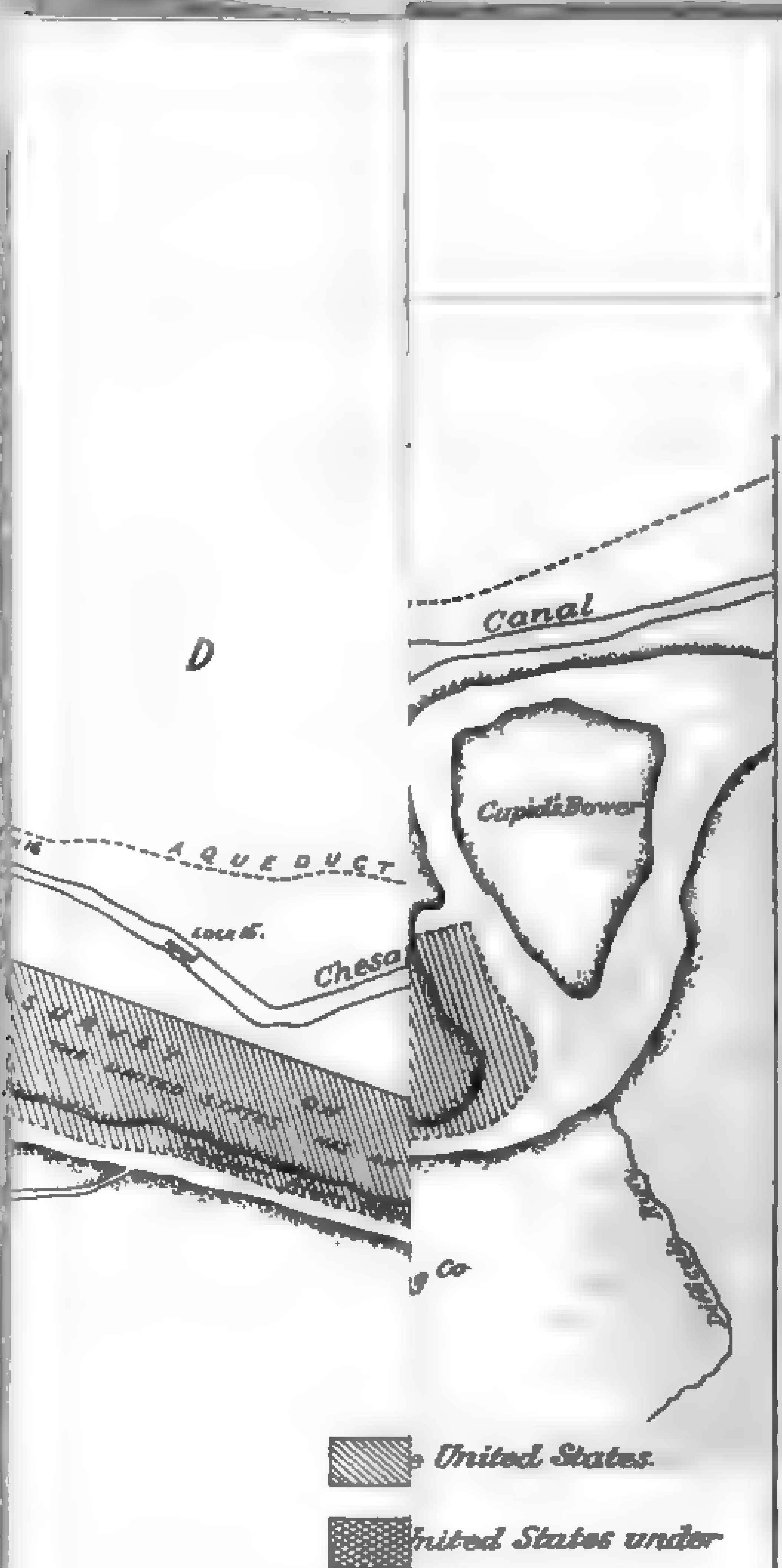
For these reasons I think it would be wise that the United States acquire now under the exercise of the right of eminent domain provided for in the bill, all of the water and water rights at Great Falls, their owners to be paid the amounts to be ascertained in the fair and just manner described in the bill.

For the reason that the capacity of a river for supply or power or both should probably be measured by its low-water flow, its greater flows being intermittent, the capacity of the Potomac at Great Falls may, according to the finding of the Court of Claims in 1879, be considered as 700,000,000 gallons of water per diem. Deducting, say, 200,000,000 gallons for the supply of the Washington of the future, there would never fail to remain for power to be used for the purposes suggested and any others that the public wants of the United States and the District of Columbia may develop a daily supply of less than 500,000,000 gallons, say 772 cubic feet per second. The fall is, as before stated, about 70 feet.

In view of the foregoing I have prepared another copy of the bill (marked B), in which are the following suggested amendments:

In section 1 strike out the words "such land and" in line 9 and insert the words "all the." Strike out the word "above" in line 10 and insert the words "in the vicinity of." Strike out, in lines 10, 11, and 12, the words "as they may deem necessary for the present and future supply for said District of Columbia." After the word "all," in line 13, insert the word "public." After the word "purposes," in line 13, insert the words "and also such land as may be necessary for these purposes." Strike out the words "ninety days" in line 13 and insert the words "nine months." Strike out, in lines 17, 18, and 19, the words "and also the quantity of water per day necessary for the above purposes (in addition to the amount already appropriated and paid for)" and substitute therefor the words "excluding the lands already purchased by the United States and paid for," and in line 30, after the word "amendment," insert the words "or otherwise."

In section 2, after the word "height" in line 5, insert the words "or by raising the dam to any height that may be deemed necessary for the future supply of the District of Columbia, and other public purposes," and strike out all of the section after the word "entitled," in line 7.


D
Canal
Cupid's Bower
AQUEDUCT
Chesa
Co
United States.
nited States under

In section 3, after the word "height" in line 6, insert the words "or by reason of raising the dam to such height as may be necessary for the purpose of this act. In making the valuations the appraisers shall only consider the present values of the land and water rights without reference to their values for the uses for which they are taken under the provisions of this act," and strike out all of the words from and including the word "and" in line 6 to and including the word "States" in line 9.

In section 4, after the word "height" in line 6, insert the words "or by reason of raising the dam to any height that may be deemed necessary for the future supply of the District of Columbia and other public purposes," and after the word "States" in line 17 add the words "*Provided*, That the United States shall be represented in such suits by special legal counsel conspicuous for known familiarity with and experience in the laws regulating riparian rights and in hydraulics."

In section 6, lines 2 and 3, strike out the words "one or more" and insert the word "two."

In section 8, line 7, after the word "referees," insert the words "and of special counsel and witnesses on behalf of the United States."

I should add that the lands and water rights at Great Falls appear to be unsettled in respect of their titles, and that I am informed that the claim of the Great Falls Manufacturing Company to the title of the Toulson tract, on the Virginia side of the river, is not acknowledged by the Chesapeake and Ohio Canal Company, which once owned and still claims to own the property.

I should also add that it is well understood that the land and water rights of the Great Falls Manufacturing Company have been for some years for sale; also that there is now pending in the Maryland legislature a charter giving to a corporation entitled the Great Falls Power Company authority to erect such dams or other structures in the Potomac River between the Great Falls and the United States aqueduct dam as may be necessary for the objects and purposes set forth in the charter, which include the selling and leasing of water power, the using of the same for manufacturing and other purposes, and for generating, transmitting, selling, or leasing electricity, electric power and light, with the provision that nothing in the act "shall be construed to give said Great Falls Power Company authority to interfere with any existing rights of the United States." In case of sale of the company's land and water rights there might be no result other than the succession of a new claimant and litigant against the United States to the Great Falls Manufacturing Company, but in case of the granting of the charter just mentioned by the State of Maryland (it has, as I understand, been already granted by the State of Virginia) I should say that if it be held or claimed that such increase is not covered by an existing right, any attempt by the United States to increase the water supply of the District of Columbia would, in the absence of legislation such as is proposed by Senate bill No. 1359, be very likely to lead to contention and litigation.*

In conclusion I may remark that the legislation provided for in the bill as amended seems to me to be of the highest importance to the United States and the District of Columbia, and, in respect of the water supply of the District of Columbia, more important than any that has been enacted since the completion of the aqueduct thirty years ago. I have pointed out what appear to me to be the objectionable features of the bill; I have suggested additions that seem to me important, and I believe the bill—if it be amended as proposed—will thoroughly guard the interests both of the United States and the District of Columbia.

I do not think the amendments that I have suggested can reasonably be opposed by either of the two coowners with the United States of the land and water rights at Great Falls, except perhaps in respect of the amendment of section 2, by striking out all of the section after the word "entitled," in line 7. The legislation proposed in this portion of the section would no doubt be of enormous advantage to these coowners, but in my judgment it would be in the highest degree inimical to the interests both of the United States and the District of Columbia, and it would be likely to lead to innumerable lawsuits.

The papers are herewith returned.

Very respectfully, your obedient servant,

GEORGE H. ELLIOT,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. Army, Washington, D. C.

---

* I understand that the charter referred to has been granted, but that before the passage of the act the Chesapeake and Ohio Canal Company caused to be inserted in the charter a provision that no works shall be constructed by the Great Falls Power Company until the plans have been submitted to the trustees of the canal company, and to the board of public works of Maryland, and approved by each. An agreement is then to be entered into and a bond filed. The United States, which has more at stake, is not thus protected.

APPENDIX 4.

SELF-PURIFICATION OF THE RIVER LIMMAT, SWITZERLAND.*

The new drainage system of the town and suburbs of Zurich dates from the year 1883, and was constructed to utilize the collected sewage in irrigating a tract of about 300 acres of land, situated about 2 miles below the town, specially acquired for that purpose by the corporation at a cost of over £40,000. Owing, however, to local opposition, the irrigation was deferred; and, in the meantime, the sewage main discharges into a collecting well close to the left bank of the Limmat, at a point about 1,090 yards below the pumping station of the water works; and thence discharges into the river by three 25-inch pipes, which are laid obliquely to the course of the river, the outfall taking place in midstream, 66 feet from either bank. The average delivery of sewage is 4,400,000 gallons, the maximum being 11,000,000 gallons per day; whilst the average flow of the Limmat, including the River Sihl, is 1,980,000,000 gallons per day; the sewage, therefore, represents about 0.2 per cent of the average daily volume of the river. The pollution of the Limmat by this outfall naturally raised great objections on the part of the riparian population in the immediate vicinity; not only because it was likely to damage iron and timber structures and water wheels by the action of ammonia and deposit of mud, but on account of the injury to be apprehended to the public health and pisciculture. The inquiry which was instituted into this matter demonstrated the fact of neither chlorides, sulphides, nitrogen, nor ammonia being present in any excessive quantity; and showed that the impure matter contained in the sewage is largely decomposed before it reaches the point of outfall. Subsequently a series of bacteriological investigations was undertaken by the Hygienic Institute of Zurich,† with the view of ascertaining whether the changes which the Limmat water undergoes owing to the sewage mixing with it render it unfit for pisciculture and the domestic purposes for which it is used lower down the river.

The inquiry was conducted by weekly investigations, extending from January to April, 1889, a season when the volume of the river is lower and more constant than any other time of the year. Samples of the water were taken at different stations (ranging according to the velocity of the river on each day, over a distance of about 10 miles), not simultaneously, but in succession; and were, within an hour or two after being taken, put under cultivation according to the bacteriological method already referred to. In a table appended hereto, the author has worked out, extended, and arranged in an intelligible form the results of these investigations; together with the meteorological data, and the volumes and velocities of the river as far as they relate to the ten days on which samples were taken at all the nine stations in succession: deducing therefrom the average number of bacteria and rate of self-purification at each station, as the only satisfactory method of arriving at a reliable conclusion.

From the table referred to it will be seen (1) that 96 per cent of the precipitation takes place within 0.3 mile below the sewage outfall; (2) that within 6 miles of the sewage outfall the number of bacteria falls to the number immediately above that point; (3) that the greater the volume and velocity of the river, the slower is the rate of self-purification; (4) that, so far as concerns the sewage, the rate of self-purification is not influenced by meteorological changes.

The River Limmat, after its confluence with the Sihl, and below the Zurich waterworks, has a fairly uniform width of about 98 feet, and a depth of about 6¼ feet, its discharge being 317,850,000 cubic feet per day; hence its mean velocity is about 4 miles per hour. Its fall from Zurich to the well-known sulphur baths of Baden, a distance of 18 miles, is 10.5 feet per mile; and the time the water takes to travel from the outflow of the lake to Baden is about five and a half hours. After passing the waterworks, the river only receives a few insignificant streams, which, although after rain they carry sand in suspension, do not materially affect the rate of self-purification of the river. Taking, therefore, the mean decrease of bacteria between two stations at 40 per cent within 6 miles, it follows that within an additional distance of 6 miles, the process of self-purification will be complete; i. e., the bacteria will be reduced to the normal number of the lake water, or about 170 per cent. And that this is actually the case is attested by the fact that at Baden the Limmat water is freely used for domestic purposes, and that fish live in it in abundance. These considerations therefore lead to the conclusion that, under the conditions described, and provided there are no intermediate sources of pollution, a river such as the Limmat, flowing at the mean velocity of about 4 miles per hour, will purify itself within a distance of about 16 miles from the point of pollution.

---

*Reprinted from a paper by Charles Sheibner Du Riche Preller, M. A., PH. D., Assoc. M. Inst. C. E., in Vol. CXI of the Minutes of Proceedings of the Institution (British) of Civil Engineers.

†Hygienic Institute, Zurich, Dr. C. Schlatter, 1890.

Self-purification of the river Limmat.

Date	Mean temperature	Rain or snow	Sectional area	Volume of flow per second	Velocity per second	Outflow from lake station 1	Mill station 2	Outfall of sewage, station 3	Mill, station 4	Ferry station 5.	Bridge station 6.	Bridge station 7.	Ferry, station 8	Ferry Diktikon, station 9.	Decrease between stations 3 and 4
						Number of bacteria per cubic centimeter.									
1896	C.		Sq. feet	Cubic feet	Feet										Per cent
February 6	2.8	Snow	581	883	1.47	117	1,290	966,070	25,270	15,060	18,270	15,000	2,220	2,000	98
February 13	10.	do	597	954	1.61	244	200	206,670	9,050	5,820	3,830	1,430	900	800	96
February 18	+4.7	Thaw	646	1,236	1.90	371	3,350	113,930	6,480	2,300	2,350	400	1,050	1,700	99
February 20	+1.3	Rain	624	1,130	1.805	498	6,870	329,290	53,470	51,140	6,370	2,950	2,470	1,080	84
February 25	4.7	Snow	646	1,201	1.93	300	1,250	60,810	1,290	1,540	600	800	1,980	510	89
February 27	5.8	do	646	1,165	1.805	100	160	56,130	340	440	150	250	250	250	99.4
March 4	−2.8	do	592	918	1.57	200	1,020	397,760	18,650	9,840	7,250	7,500	3,000	3,900	95
March 6	2.8	do	603	989	1.64	213	1,220	764,090	28,700	16,160	14,270	5,700	1,940	3,130	97
April 26	+6.3	Rain.	707	3,240	4.07	83	1,050	37,580	2,220	2,640	4,000	2,540	5,100	5,100	94
April 30	+11.0	do	904	4,414	4.87	125	1,000	33,770	3,000	4,380	1,650	5,560	3,950	3,550	91
Average	−3.1		664	1,614	2.28	225	1,731	296,670	12,870	10,892	5,902	4,218	2,346	2,100	.....
Increase or decrease, per cent			.....	.....	.....	.....	+770 177.7	+17,138 1,171.4	−96	15	−46	−28	−45	−10	.....
								Mean decrease between 2 stations = 40 per cent.							
Distance between stations ..... feet							9,843	1,640	1,640	1,640	3,281	13,124	1,640	11,483	44,292
Distances from station 1 ..... miles							1.86	2.175	2.485	2.796	3.417	5.903	6.214	8.078	8.078

$\frac{2,100+100}{296,670}=0.7$; $100-0.7=99.3$ per cent, decrease 99.3 per cent in 6 miles.

Self-purification in 12 miles.

At—	Bacteria per cubic centimeter.		Distance from lake.	Distance from sewage outfall.
	No.	*Per cent.*	*Miles.*	*Miles.*
Station 9	2,100		13.5	6.21
Station 10	1,260	—40	15.5	7.46
Station 11	756	—40	17.5	8.70
Station 12	452	—40	19.5	9.94
Station 13	272	—40	21.5	11.18
Station 14	164	—40	23.5	12.42

At station 14, 12 miles from sewage outfall, the water is as pure as at its issue from the lake. (Bacteria at outflow from lake=225.)

APPENDIX 5.

E PURIFICATION OF DRINKING WATER BY SAND FILTRATION: ITS THEORY, PRAC-ICE, AND RESULTS; WITH SPECIAL REFERENCE TO AMERICAN NEEDS AND EURO-EAN EXPERIENCE.*

By WILLIAM T. SEDGWICK, PH. D.,

fessor of biology, Massachusetts Institute of Technology, Boston, and chief biologist to the State board of health of Massachusetts.

[Reprint from Journal of the New England Waterworks Association, December 1892.]

t has become an axiom that one of the fundamental sanitary requirements of lized communities is an abundant supply of pure water. To the requirement of ndance American communities have been quick to respond. The statistics of erican waterworks testify to the energy and spirit which have furnished thou-ds of our cities and towns with bountiful supplies of water and with waterworks h extensive and costly.

here is reason to believe, however, that we have given hitherto relatively too much ntion to waterworks and not enough to water. In meeting the requirement of ndance we have done well; but in the equally fundamental and equally impor-t requirement of purity of our water supplies we have too often failed. It is niliating but it is true that the sanitary condition of many of our otherwise ellent water supplies is to-day discreditable to American science, American ineering, and American civilization. So long as the water supplies of important es like Chicago, Philadelphia, Albany, Lowell, Lawrence, and St. Louis remain their present condition so long will they constitute a blemish upon our fair civili-ion.

city or town may dig wonderful tunnels; it may build great waterworks or magnificent pumps, but if any or all of these convey impure water from fouled es or polluted rivers, if they occasionally deliver to the confiding citizen in his rkshop or in his home the deadly germs of disease, they must be set down by all e persons as lamentable failures, because dangerous to the public health.

t is worth our while to inquire how it has come to pass that so many cities ndidly equipped with waterworks and ably officered, are still supplied with er that is obviously polluted with raw sewage, and is shown by statistics to be rier of the germs of specific disease. The only explanation that I have been to discover is the following:

til lately the selection of sources of water supply has been largely influenced he belief that impure water quickly, naturally, and effectually purifies itself. n, we have often failed to foresee the growth of our own or of neighboring pop-ons, and therefore the consequent difficulty of maintaining the purity of natural es of supply, such as lakes and rivers. The latter fact is the more remarkable, se as a people we have never failed to proclaim the future greatness of our or the rapid strides of our population. Yet we may well believe that Chicago l have adopted a different system of water supply, if when it began to dig the ake tunnel it had dreamed of its future greatness. We can easily believe that delphia, Albany, Lowell, Lawrence, and St. Louis would have sought other es or means of supply if when their waterworks were introduced they had n that the self-purification of rivers is only a half truth, and that by the use filtered river water they might make typhoid fever virtually endemic within borders.

are but just beginning to realize the mischief which a too eager reliance upon eory of the rapid and effectual self-purification of polluted waters has done. truths are often more dangerous than error. We are learning to our cost that s case we have leaned upon a bent if not a broken reed. To show how slow has the recognition of this fact we need to remember that it is only seven years a distinguished authority, referring to the polluted Mohawk-Hudson, solemnly d the people of Albany, through their water commissioners, that "there is no n why the city of Albany should not continue to use this water," and reaffirmed rlier opinion that "the most careful examination of the water has failed to l anything to sight, taste, smell, or analysis, which can be considered as throw-he slightest suspicion upon the purity of the Hudson, or its fitness for supply-perfectly wholesome beverage for the citizens of Albany." It was only in nber last that a prominent Chicago newspaper, with astonishing ignorance or tery, boasted of the magnificent water supply of that city, asserting that Chi-has at its doors an unlimited supply of the purest water in the world, to be for the mere cost of pumping. Six weeks later the same newspaper was implor-ts readers to boil the city water before drinking it, and childishly ascribing the lation of the natural consequences of its use to an imaginary eastern jealousy.

*An address (illustrated by stereopticon) delivered at the annual meeting in yoke, Mass., June 10, 1892.

After making all allowance, however, for the unfortunate and undue influence of the self-purification theory, and for our strange inability to foresee and provide for a probable growth of population of which we were at the time loudly boasting, much still remains chargeable only to gross carelessness or indifference. The probable pollution of the Chicago water supply was officially pointed out by the State board of health of Illinois in 1881, and further demonstrated in 1886, but no remedy has yet been applied. Typhoid fever has long been excessive in Philadelphia; but so far as I am aware no steps have yet been taken to remedy the evil, although there is every reason to attribute the excess chiefly to the use of unfiltered polluted river water.

Lawrence languidly discusses but has not yet begun to remedy the dangerous condition of her water supply, polluted only nine miles above the intake by the sewage of 80,000 people, and further up by that of as many more. Meantime typhoid fever ravages the city, claiming relatively more victims from Lawrence than from any other city of the State. Lowell also proceeds but slowly toward purification of her water supply, which is only somewhat less objectionable than that of Lawrence. Yet it can no longer be claimed that the dangers of polluted drinking water are doubtful or imaginary. The citizens of Paris are officially warned when the water of the Seine is about to be supplied to them. The citizens of Chicago, Lowell, and Lawrence have all been warned against their public drinking water in its unfiltered condition, and we can not doubt that those of many other cities ought to be so warned.*

The eminent statistician Korosi has recently shown in a very valuable paper that typhoid fever has prevailed to an unusual extent in Budapest within the past four years. The water supply of Budapest is drawn from the Danube, a highly polluted source. Some portions of the city receive the river water purified by sand filtration; other portions get the Danube water entirely unfiltered. Comparing certain of these districts Korosi was led to conclude, upon purely statistical grounds, that, in proportion to the population, typhoid fever was twice as abundant among those using the Danube water raw as among those who used it after sand filtration. His natural conclusion is that the substitution of filtered for unfiltered polluted waters, with a view to the reduction of typhoid fever mortality, is much to be desired.

We have met to-night, however, not so much to discuss the fact or the origin of the unfortunate conditions which exist in many American cities and towns, as to consider what we can do to abate them. Here, I think, we may profit by European experience. Civilized European cities are few in which raw river water or unfiltered sewage-polluted water of any kind, is delivered to the people as their source of supply for drinking purposes. I believe that the time is at hand when in America, also, we shall cease to use unpurified water for drinking, and must turn for relief to some process of purification; and I venture to predict that within the decade we shall witness the establishment of numerous and extensive municipal systems of water purification by some form of sand filtration.

The purification of water from the sanitary standpoint is the most difficult kind of purification.

The principal natural methods contributing to the sanitary improvement of water are sedimentation, storage, and filtration. Light, temperature, pressure, and electricity have their effects, but an impure water is purified in nature chiefly by settling, for the bacteria have weight, and at least in some stages of their development tend to settle; by storage, which has a double action shortly to be explained, and by filtration through the earth.

Storage has immense sanitary value and has not been hitherto sufficiently appreciated. There is good reason to believe that a water otherwise good but containing disease germs might be rendered wholesome and pure by simple storage. Under such conditions some of the bacteria settle to the bottom and eventually perish; some are destroyed by light, but the disease germs, being apparently in water somewhat short-lived, perish. It is also a fact that living bacteria largely disappear in the pipes of a service. To these facts we must look for the explanation of the limited infectiousness in some cases by water obviously badly polluted with raw sewage. I am convinced that if Lawrence, for example, pumped directly into the pipes, as Chicago does, her death rate from typhoid fever would be far greater than it is. A recent writer has urged that sewage-polluted water be drunk as soon as possible after its pollution, in order to avoid the disagreeable putrefactive phenomena which might ensue; but if what has just been said is true, it is plain that to do this is to invite disaster; it is the same kind of advice which would lead us to strain at a gnat and swallow a camel.

The sanitary value of storage is not yet, by any means, as well known as it deserves to be. Storage involves the element of time, time gives opportunity for

*Since this address was made Chicago has begun to dig an immense sewage canal, which, when completed, will probably improve her water supply, Lawrence has adopted a system of sand filtration, and Lowell has appropriated $100,000 toward improvement of its public water supply.

change, and the changes which storage tends to effect in polluted water are often of the highest sanitary significance. There is no evidence that disease germs multiply in ordinary natural waters. Such evidence as we have, both from experiment and experience, indicates, on the contrary, that disease germs die out more or less rapidly in good natural waters. Time, therefore, is an all-important element in the sanitary improvement of infected waters, and we may safely say that infected water, like wine, improves with age. Here is one element of great sanitary value in storage. It may be called the vital element. Another element is sedimentation. This is mechanical instead of vital in its action, but is unquestionably of very great value in the purification of water. The germs of disease, though microscopic, are material, and they are subject to the law of gravity. They are also easily dragged down by heavier masses in their settling, and a muddy water may, on standing, purify itself to a remarkable degree merely by settling. Thus storage, by bringing in the element of time, allowing the disease particles to die out, and by favoring sedimentation, is of immense sanitary value, while settling basins for muddy waters not only clarify, but to a greater or less extent also actually purify the water which passes through them. It is probably for this reason that St. Louis has fared as well as it has hitherto. Particularly valuable is the storage of flood waters, because in times of flood infectious material is more rapidly transported than usual from point to point. The great water companies that so ably supply the wants of the largest city in the world make a special point of the storage of the floood waters of the Thames and the Lea, and that they are right in doing so the vital statistics of London amply demonstrate.

I know that there is another side to the storage question. I know that stored waters exposed to the light are apt to become troubled by unsightly and ill-smelling growths. I know that if the latter provoke disgust or nausea in the consumer the sanitary value of storage is justly called in question. But in spite of these drawbacks, which can not be overlooked, it is still true that storage, by favoring sedimentation and giving time for specific disease germs to die out, is, nevertheless, from the sanitary standpoint, of great value in the purification of polluted waters.

To recapitulate: Sedimentation is a valuable means for the purification of water and has its sanitary value in removing disease germs from flowing or standing water. St. Louis has great settling basins in which the muddy water of the Mississppi is settled. Here, in addition to their own tendency to fall by gravity, the removal of the disease germs is probably greatly aided by the falling particles of mud which drag them down. Storage is of great sanitary value, first by giving time and opportunity for sedimentation, and secondly by giving time for the disease germs to die out. New York doubtless derives much sanitary advantage from her great storage system. Neither of these methods of purification, however, is entirely trustworthy. If the storage is too brief some germs will survive; if the sedimentation is incomplete the effluent from the settling basins will still be unsafe.

There is another natural method, however, which is more common and more trustworthy. This is filtration through the earth or sand. I do not need to do more than to remind you of the pure spring which pours from the earth, germ free, its sparkling water originally the rain or snow, but since filtered through deep layers of the earth; or of well waters, which, in spite of their occasional privy and barnyard origin are, as a rule, free from the germs of disease. Yet these are really filtered surface waters, and in their history we may discover the secret of the more extensive purification of great bodies of water, such as lakes and rivers. The fouled waters of barnyards if run off upon the farmer's meadow become purified. Even the more solid stable manure thickly spread upon the field, if committed to the earth and turned under by the plow, readily disappear. These examples and the more familiar results of burial show how the earth—the living earth, as it has been well called—teeming as it is with bacteria and other micro-organisms, purifies organic matters, even when they are in the fluid state. But apart from this vital action, earth, and especially sand, is an excellent strainer. Ordinary loam is too fine and soon gets clogged, but sand, especially after it has become partly clogged, is a capital filter, for it works rapidly and yet so effectively as to retain even the bacteria in the applied liquid. Long before the immense purifying capacity of sand filtration could be demonstrated scientifically it had been proved by experience. Wells sunk in the earth have been known from the earliest times, and have often given excellent water, though sunk in regions in bad sanitary condition. When in 1850 the dangerous pollution of the Thames and the London water supply was demonstrated by Dr. Hassall, by means of the first systematic microscopical examination of a public water supply ever attempted, the remedy applied was storage and sand filtration. The steady improvement in the sanitary condition of London, which is to-day the wonder and the envy of the world, is due in no small measure to the protection afforded by her now very extensive system of sand filtration. I am myself persuaded that in scientifically conducted sand filtration we have a complete solution of the problem of a safe and sanitary water supply. I am ready to agree with Fraenkel,

the professor of hygiene at Marburg, and Piefke, the accomplished engineer of the Berlin-Stralau waterworks, when they affirm that:

I. Every surface water before it is used for drinking purposes, should be freed from all infectious substances.

II. For this purpose, whenever large quantities of water are to be treated, sand filtration is at present the most convenient and effective method.

It is not claimed that all waters need to be filtered, but when a city or town is so unfortunate as to be obliged to use a polluted source of supply there can be no question whatever as to the requirements of modern sanitary science; the water must first be freed from infectious materials. For this purpose there is nothing better known to sanitary science at present than scientifically conducted sand filtration.

It is said that sand filtration was first introduced at Chelsea, near London, by James Simpson, in 1839. At the time of the celebrated microscopical examination of the London water supply by Dr. Hassall, in 1850, the water supplied to London was indeed "filtered" by the companies, but so badly that it was scarcely strained, for Dr. Hassall found fish and many smaller objects in the filtered water. After much debate and many inquiries, a water act was passed for London in 1852, which prescribed effectual filtration and storage of the London water supply, to be in operation in 1855, regulated the charges and made other arrangements between the citizens and the eight water companies. The results obtained were so good that the rules then adopted have been followed upon the continent, and the English practice has since served as a model here, as in other branches of sanitary science, to the rest of Europe, and to the world. Reserving for the end of this paper a more complete account of the English practice, as exemplified in London, let us turn first to the purification of the water supply of the German capital, Berlin. This city has now a population in round numbers of one and one-half millions, and it has probably the best examples of sand filters to be found on the continent. Berlin is supplied from two sources, one a lake, Lake Tegel, and the other a river, the Spree, which, below the intake, passes through the city. We may first describe the older establishment, that at the river, known as the Stralau waterworks, under the able administration of C. Piefke, whose studies upon the theory and practice of sand filtration have placed him among the very first of European sanitary engineers. I am personally indebted to Herr Piefke for his courtesy in offering me every facility to study the operation of the Berlin-Stralau works on the occasion of my visit to them in 1891. I have also his permission to make use of his published accounts of his work.

SAND FILTRATION OF THE PUBLIC WATER SUPPLY OF BERLIN.

(*a*) *The Stralau waterworks.*—The general location and plan of the filters which purify the water of the Spree are shown on Pl. II.* The position of the two intakes is shown at *a* (the older) and at *b* (the more recent). From *a* the water flows by gravity to the pumps along the line indicated. From *b* the water is drawn directly by the pumps. From these it passes in a common main along the lines *ll* to the several filters, but as it is impossible to adjust the pumps to the varying demands of the filters this supply main ends in a small supply or compensating (*Vorraths*) reservoir, shown on the northern border of the filters. When the pumps are not working the supply for the filters is drawn from this. Its capacity is 11,000 cubic meters (2,906,000 gallons). This reservoir, with the open filters Nos. I–IV, near by, represents the oldest portion of the plant. Originally it served in good measure as a settling basin, but as new filters have been added this function has gradually diminished, until now the daily output of the plant far exceeds the capacity of the reservoir and it serves as little more than a regulating or compensating reservoir of unfiltered water. It is but just to say that, owing to the enormous growth of Berlin, the present system is said to be decidedly overtaxed. More filters should be added immediately, and I am informed that steps have been taken looking to this end. Since 1873 the Stralau works have consisted of 37,067 square meters (about 9 acres) of filtering surface, arranged in eleven independent sections or basins. They may be worked separately or together.

The normal maximal output of the whole plant is placed by Piefke at 60,000 cubic meters (15,850,000 gallons) every twenty-four hours. But sometimes, on special occasions, it has been as much as 70,000 or even 80,000 cubic meters (18,000,000 and 21,000,000 gallons). Three of the filters (Nos. IX–XI), having a combined area of 9,000 square meters (2.2 acres), are covered, to guard against severe and prolonged cold weather. In winter the daily consumption (from this plant) sinks, as a rule, to 30,000 cubic meters (7,925,000 gallons). It ought to be said, at this point, that the newer Tegel waterworks (to be described beyond) supply a comparatively fixed quantity of filtered water to Berlin, summer and winter alike. The extra demand of the summer falls, therefore, largely upon the older works at Stralau, and these

* In this reprint the plates and illustrations have been omitted.

are at times plainly overtaxed, giving too rapid filtration with incomplete purification.*

The filtered water is drawn off beneath the several filters by underdrains which convey the water to a reservoir for purified water (*Reinwasser*) placed at such a depth as to receive the effluent by gravity. (See Pl. II and Pl. V, figs. 1 and 2.) This has a total capacity of only 2,200 cubic meters (581,000 gallons). The sand-washing establishment, which at Berlin is regarded as a most important feature, is located in the angle between filters No. VI and No. IX (Pl. II). The engine and boiler houses, the office, and the dwellings of the resident engineer, etc., are shown in section on the street front (Pl. II).

The intake, located at *b* on Pl. II, is shown in elevation, plan, and sections on Pl. III, and requires no special remarks. The filters are shown in sections (transverse and longitudinal) on Pl. IV. Fig. 1 shows a longitudinal section through the underdrain. Fig. 2 is a cross section showing the (central) underdrain, the overflow waste pipe, and the general arrangement and construction of the filters. For the details of the construction I must refer the reader to the original paper of Piefke. Suffice it to say that the bottom must be water tight and the sides strong enough to support the pressure of the inclosed water. Those at Berlin-Stralau are laid upon clay (*Thon*), covered with concrete (*Beton*). (See Pl. IV, fig. 2.) Fig. 6 is a section through one of the covered filters (Pl. II, Nos. IX-XI), showing the piers, arches, and the openings to admit light during the process of cleaning the filter. Piefke remarks, however, that for cleaning artificial light is, on the whole, to be preferred to the scanty daylight which can be admitted in this way. The actual filtering materials used at the Stralau works and resting upon the concrete are as follows, beginning at the top:

	Inches.
Fine sharp sand	22
Coarse sand	2
Fine gravel	6
Medium gravel	5
Coarse gravel	3
Small stones	4
Large stones	12
Total	54

It is interesting to compare this construction with that of the London filters shown in the tables beyond (see Appendix, pp. 4–7), as well as with the sand filters of Zurich and Warsaw (p. 115) and the Berlin-Tegel works (p. 113). Piefke expressly states that he does not consider a greater depth of sand to be of much advantage, provided that the sand shall be sharp, and he believes that more time and trouble is often spent upon these details of the actual filtering materials than is necessary. The underdrains connect directly with the lower layers of the filter, so that while the water sinks vertically through the sand it flows laterally through the coarser underlying layers. From time to time the filter must be drained for cleaning. If it is not desired to drain it completely, but only for scraping the very surface, the valve shown at *v* in Pl. IV, fig. 2, and connecting with the overflow (*u*) may be opened. If it is desired to drain the filter thoroughly, another valve known as the "sand cock" (*Sandhahn*), shown in elevation in fig. 4 and in section in fig. 5, may be opened. I must pass over many interesting details of the actual management of the filters, which are fully described by Piefke in the paper referred to. Numerous automatic devices for detecting the precise conditions at any particular moment, and for aiding the superintendent, have been introduced at Berlin; but for these also I must refer the reader to the original paper.

The ordinary process of filtration is conducted as follows: After a filter has been worked for a time it is found to have become clogged and allows the water to pass through only very slowly. The arrival of this time is shown by an automatic telltale float (*w*) seen in section in fig. 1. If, with the valve *k* closed, this float rises but very slowly, it is clear that in spite of a high pressure of the supernatant water (*h*) only a little passes through the sand. The filter is then described as "dead," and must be cleaned. It is therefore drained, and a gang of men is set to work on it with broad tin shovels, or with special "scrapers." A plank track is laid on an incline down into the basin and the scrapings are taken away in wheelbarrows to the sand-washing house.

At the time of my visit a gang of perhaps thirty men was cleaning a filter. Only the uppermost layer of sand and the dirt deposit upon it was removed. This dirt deposit or *Schmutzdecke* is extremely interesting. In Berlin I found it to consist of a thin membranous layer of a greenish brown color and so well defined that it could

* These and the following data are taken from Piefke, Aphorismen über Wasserversorgung, II. Zeit. für Hygiene, VIII, 1890.

be easily peeled off in flakes from the sand below very much as a moistened postage stamp can be peeled from a piece of paper to which it has become partially attached. The sand below the *Schmutzdecke* was clean and white to a very noticeable and striking degree, so that it was obvious that only the *Schmutzdecke* required to be removed. Carefully detached by the scrapers, it was drawn up into little heaps of a peck or a half bushel each and these were carried away on the wheelbarrows to the sand-washing establishment. Once the *Schmutzdecke* has been removed and the life of the filter is restored, the sand is smoothed, the filter slowly filled from below (with clean water) to drive out all air and prevent fissures or channels, and the whole covered with unfiltered water to the depth of about 3 or 4 feet through the inflow pipe. (Pl. IV, fig. 3.) Meantime the outlet is kept closed, so that the supernatant water stands quietly upon the sand and is allowed to settle. This is a point of much importance, as the consequence of this settling is the formation of a delicate membrane or new *Schmutzdecke* upon the clean sand. After a time, varying with the demands upon the plant, the effluent is allowed to escape, fresh unfiltered water flows upon the filter, and filtration proceeds. At first it is, of course, rapid and comparatively imperfect, but as the membranous deposit (*Schmutzdecke*) thickens it grows slower and yields a better effluent. The filtration continues with increasing head and diminishing rate until the *Schmutzdecke* becomes almost impervious, when the filter is said to be "dead" and once more ready for cleaning.

By the kindness of Herr Piefke I was able to examine carefully the *Schmutzdecke* both in situ and microscopically. It consisted of much brown amorphous matter (zoogloea), numerous filaments of algæ, giving to the whole its dark greenish tinge and its firm felted or membranous character, besides particles of woody fiber, débris, etc. The smooth and almost slimy feel of the membrane appeared to be due chiefly to the algæ and the zoogloea. The membrane was perhaps one-eighth to one-sixteenth of an inch in thickness. I have described the *Schmutzdecke* (surface deposit) in some detail, both because I was much impressed by its well-defined character and position, and also because, according to Piefke, this membranous deposit is the principle factor in efficient sand filtration. One who sees it as I saw it (toward the end of August, 1891), upon an open, but "dead" filter, can not help perceiving that such a micro-membrane must indeed play a most important part in continuous filtration. From its peculiar composition and semigelatinous character, it must be highly effective in the detention of all suspended particles of whatever kind, including bacteria. When the *Schmutzdecke* is so well defined as it usually appears to be at Berlin the sand below it looks bright and fresh. At the Stralau works the depth of sand may well be thought to be of secondary importance, the real filter being the micro-membrane. Whether it is always of so little importance may be more open to question.

Naturally, at Berlin, the scraping is so arranged as to remove as little sand each time as possible. Gradually, however, the sand layer grows thinner, and after a time it must be replenished with new (or washed) sand to the original depth. This happens about once in two years, and requires considerable time. Even the ordinary scraping requires that the filter shall be out of connection for several days. At some seasons scraping is required (in Berlin) very often (once a week), but in winter very seldom (once in two or three months). The Spree is not muddy like the Mississippi, but at times is very unclean, and in summer contains vast quantities of certain algæ which are particularly troublesome, making an almost impervious "felt" through which the water moves only very slowly.

The sand washing is done at Berlin because it is found to be cheaper than to import new sand. The position of the sand-washing establishment is shown on Pl. II. Some of the details of the apparatus employed are shown on Pl. VI. Fig. 1 shows the ground plan, and fig. 2 the section. Fig. 3 is the revolving drum in which the sand is washed. Fig. 4 is the section A-B on fig. 1. Figs. 5 and 6 shows sections of a centrifugal pump. This is a very interesting portion of the work, but space forbids me to enter upon it in detail. Piefke states that all of the filters are cleaned perhaps twenty times annually, and that about one-third of the filtering material has, therefore, to be washed or otherwise renewed yearly.

(*B*) *The Berlin waterworks at Lake Tegel.*—To keep pace with the growth of Berlin and the increasing consumption of water a new and separate establishment was, in 1877, added to that at Stralau and located on the other side of the city, by the southern shore of Lake Tegel. The following account of the Tegel waterworks is drawn almost exclusively from the admirable account of the works given by the resident engineer, G. Anklamm, and published with additions, as a reprint from Glaser's Annalen fur Gewerbe und Bauwesen, Bd. XIX, Berlin, 1886. I have ventured to reproduce from this two of Anklamm's admirable and instructive plates. (See Pls. VII, and VIII.) Pl. VII shows the general location and plan of the Tegel works with some details of construction of the (covered) filters. Pl. VIII shows the several parts of the sand-washing apparatus.

Originally the attempt was made to obtain a supply of pure water without filtration from the shores of the lake by sinking there a number of wells. These at first yielded an excellent supply, but after a time the water deteriorated, owing to the growth in the wells and in the mains of an iron-bearing bacterium *Crenothrix*. This grew to such an extent in the Tegal water supply as to constitute what has been called "the Berlin water calamity." To obviate the difficulty commissions were appointed, investigations were made, aeration and other means of relief were attempted, but without avail. At length, about 1883, sand filters were established to treat the water taken from the lake and these, ever since their installation, have yielded an admirable effluent.

When they were first put in operation the mains and service pipes contained an abundant vegetation of *Crenothrix*, but little by little this disappeared in the presence of the filtered water. The area of the four larger filters is in round numbers 2,500 square meters (27,000 square feet) each; that of the six smaller ones, 2,000 square meters (21,000 square feet). The total filtering area is about 22,000 square meters (236,700 square feet, or between five and six acres). The normal yield of the filter is placed at 3 cubic meters of water, or each square meter of filtering service for twenty-four hours, or roughly, at 3,000,000 gallons per day per acre. Seven of the ten filters are usually running at once and serve to furnish the requisite quantity of filtered water. The other filters, three in number, serve as a reserve and also for use in the summer time, when the life of the filters is shorter. The filters are all covered, and in order to keep a temperature as low as possible in summer, they are covered with a layer of earth 40 to 70 centimeters thick. This layer is covered with grass.

The filtering material consists of three layers. The lowest is about 30 centimeters thick, of rounded granite stones. Upon this there rests a layer about 30 centimeters thick of coarse, clean river gravel, free of sand, and upon this a layer about 60 centimeters thick of medium coarse sand. The average diameter of the sand grains is about one-third of a millimeter. Before the material is placed in position it is carefully cleaned from clay and dirt by special washings. Each filter is fitted with an under drain, with feed pipes, etc. The filter is filled as at Stralau from below in order to drive out the air particles contained in the sand. This filling must be done slowly, for otherwise air will remain in spite of it, and will interfere with the successful operation of the filters by forming, during its escape, canals, through which organisms can penetrate into the under layers of sand or gravel.

After the filter has been operated for some time a gelatinous layer (*Schmutzdecke* of Piefke) is formed of such imperviousness that each square meter of surface will no longer furnish as much as 3 cubic meters (800 gallons) of water in twenty-four hours. When this time has arrived the filter must be scraped, but before the supply is cut off the feed valve is opened wide for a few minutes in order to clean out the feed pipe, and wash away the snails, mussels, and deposits of dirt, etc., which accumulate in it. In some cases it is said that as many as 12 hectoliters (several bushels) of snails and the like have been washed out of a single feed pipe. After the valve has been closed and the water has sunk to a depth of 50 or 60 centimeters upon the filter the outflow valve of the under drains is also closed, and the water still upon the filter is run off through the waste pipe. The thin layer of dirty sand to the depth of 10 or 15 millimeters, ($\frac{1}{3}$ to $\frac{1}{2}$ inch) is then removed by means of broad sharp shovels, and wheeled off to the sand-washing machine. After removing this portion of sand the filter is once more filled with water from below, and set in operation. As a rule, however, this is not done at once. Whenever the demand for the filter is not too great it is allowed to rest after cleaning for some time, in the belief that those particles of the dirt deposit (*Schmutzdecke*) which have penetrated unto the lower layers will be oxidized under prolonged contact with the air. In order to facilitate this operation, special attempts are made to secure a certain circulation of the air in the filtering materials. The life of the filters is naturally comparatively brief in the summer months. While it rises as high as eighty days in the winter, it sinks in midsummer, at the time of the so-called "water blossoming," not infrequently as low as ten days. On an average for the year, it is about thirty days. Replenishing with new or clean sand occurs comparatively seldom, and only after the sand layer, originally 60 centimeters thick, has been gradually worn down to 30 centimeters.

The regulating apparatus at the Tegel filters is of great interest, and for the orderly management of the filters is extremely important. It will be seen at a glance that a new filter, as yet unclogged, will offer much less resistance to the passage of the water than an older filter more or less clogged that is covered with the *Schmutzdecke*. It becomes necessary, therefore, to work an old filter under the greater head, and in order that the output shall remain constant, this head must be gradually increased. Special devices to accomplish this end have been introduced by Henry Gill, esq., chief engineer of the entire Berlin water supply, by W. H. Lindley, of Frankfort, and by others. Some of these will be described beyond.

I have entered somewhat at length into descriptions of the Berlin filters because they are probably, on the whole, the most carefully planned and most thoroughly studied of any filters on the continent. I may now briefly refer to a few other continental sand filters.

Sand filters at Warsaw, Russia.—The source of the public water supply of Warsaw is the river Vistula. The water is first run into settling basins, and then upon the filters. The capacity of the filters is about 2.4 cubic meters per square meter of surface every twenty-four hours. Pl. I, at the beginning of this paper, shows the arrangement of one of the (covered) filters at Warsaw. It will be seen that upon 11 inches of stones, there are 6 inches of smaller stones, above these 6 inches still smaller, and upon this layer 3 inches of coarse gravel, covered by 2 inches of fine gravel, and the whole surmounted by 2 feet of fine sand. The passages for the filtered water are shown as spaces between the bricks on the right of the figure. The feed pipe is also shown on the right. At Warsaw it is not customary to wash the sand, as at Berlin (and many other places), fresh sand being found to be cheaper. At Warsaw a filter of 2,100 square meters area was scraped by 15 men in ten hours, and replenished with new sand by the same number of men in four days. The depth of water upon the filters at Warsaw is kept at 1.2 meters.*

Sand filters at Oporto.—Sand filters have been provided for Oporto by the Compagnie generale des eaux of Paris. The water is taken from the river Souza. The arrangement of the filters is as follows: The supporting layer consists of stones (large) 0.15 meter stones (small) 0.15 meter upon which come first coarse sand 0.10 meter and fine sand at the top 0.20 meter making a total of 0.60 meter. The total area of the filters is 1,190 square meters, with a normal depth of water of 0.90 meter. The filters yield on an average 13 cubic meters of water per square meter for twenty-four hours. This system is said to be open to much criticism, probably from its slight depth of sand and high rate of filtration.

Sand filters at Zurich.—In consequence of an extensive epidemic of typhoid fever in Zurich in 1884, which was traced to the pollution of the public water supply, a water commission was appointed and prepared a report recommending the installation of a system of sand filters. They advised that water should be taken from the lake (Zurich) at least 200 meters from the shore, and filtered upon sand filters at the rate of 6 to 8 meters (vertical water column) per day. Inasmuch as the requirement of the city was only about 20,000 cubic meters daily, they estimated that a filter area of 3,000 or 3,500 square meters would be sufficient. This enormous rate of filtration was recommended because of the comparative initial purity of the lake water. It was recognized, however, that extra land should be secured, so that by extension of the plant even with increased consumption the rate need not exceed more than 3 meters per day.

In December, 1885, three of the five filters were in operation, and in the following August the fourth and fifth were added. The combined area of the five filters was 3,500 square meters. For extension of the plant space was reserved to the extent of 75,000 square meters. Filters Nos. 1, 2, and 3 are covered; Nos. 4 and 5 are open; all five have the same area, with about 672 square meters of effective surface. The filtering material lies upon a solid foundation covered with two layers of brick, and consists from below upwards of the following layers: 5 to 15 centimeters of coarse gravel; upon this 10 centimeters of garden gravel carrying 15 centimeters of quite coarse sand, which is surmounted by 80 centimeters of fine sand. The regulation of the rapidity of filtration is accomplished for each filter separately. When the head or difference in level between the filtered and unfiltered water reaches 60 to 80 centimeters, cleaning of that particular filter generally takes place. Cleaning consists in draining off all the water and scraping away the uppermost sand layer with iron shovels to the depth of about 2 centimeters. Experience shows that only a thin slimy layer (*Schmutzdecke* of Piefke) covers the otherwise clean sand, and that this layer is only a few millimeters in thickness. After cleaning, the filter is filled from below with filtered water and once more filtration proceeds. The water which first comes through after cleaning is, however, rejected during this early period and the dirt carried up from the sand by the water after filling and which consists of floating particles of slimy material, is removed as far as possible by letting it run off from the top before filtering begins. In 1887 the cleaning was necessary, on an average, for the covered filters every forty-eight days. As a result of these periodical scrapings the layer of fine sand gradually grows thinner, and when it has sunk so that it is only 50 centimeters in thickness, it is either replenished with clean sand up to 80 centimeters, or it is taken out altogether and replaced by a fresh sand layer of

*For a more complete account of the Warsaw filters and a full and admirable statement of the problem of the purification of river waters for drinking purposes, see W. H. Lindley, Vierteljahr. für Oeff. Gesundheitspflege, 1890, p. 191. Also an abstract in this journal, vol. 5, p. 33, 1890.

the original thickness. This renewal of the filtering material did not become necessary until after the end of 1888.*

Sand filters in Rotterdam.—The city of Rotterdam takes its water supply from a tidal stream, the Maas. Into this stream the sewage of the city also flows. By the situation of the intake and the time of taking in water for filtration, most of the danger of sewage contamination from Rotterdam itself is supposed to be avoided. The Maas, however, is by no means a pure source of supply, and it is often, if not usually, very muddy. The water is first passed into large settling basins, to which it flows by gravity. From the settling basins it is lifted by pumps and afterwards flows upon a series of sand filters. Owing to the limited capacity of the works, and to the large consumption of the city, the water is not allowed to stand in the settling basins as long as is considered desirable, and the filtration is far more rapid than the superintendent regards as proper. The effluent is now clear, bright, and entirely unobjectionable in appearance, and has never caused complaint in the city until a few years since, when the whole system became filled with the much-dreaded "pest of waterworks" *Crenothrix*. This produced complaint, and such a deterioration in the water as to excite the greatest anxiety on the part of the public as well as of the officials. Prof. DeVries, of Amsterdam, has published a valuable account of the investigation made by himself and other members of the commission which sought to discover the cause of the evil and a remedy for it. Prof. DeVries concluded that the imperfect settling, the excessively rapid filtration, and the existence in some places beneath the filter of old wooden beams, etc., all taken together allowed a sufficient quantity of organic matter to pass into the mains to support a luxuriant vegetation of *Crenothrix*.

I visited the works at Rotterdam in the summer of 1891, and it was obvious to me that, in comparison with the sand filters at Berlin, those at Rotterdam were insufficient and overworked. I am unable to give exact figures as to the depth of the sand, the intervals of scraping, the rate of filtration, the daily yield, etc., but the general construction of the sand filters was similar to that of the Berlin filters. It was noticeable, however, that here the well-defined *Schmutzdecke* of Berlin was absent. The sand appeared dirty to a considerable depth, and there was every evidence of overworked filters treating a water originally much worse than any that I had seen. I am under great obligations to Mr. Vogel, the engineer in charge, who showed me every courtesy.†

Enough has now been said of actual sand filters on the continent, but as to their operation and their efficiency something may still be said. In September, 1890, there occurred at Brunswick the annual meeting of the German Public Health Association. At this meeting the subject of sand filters for municipal waterworks was fully discussed by Fraenkel, the distinguished bacteriologist, and Piefke, the accomplished resident engineer in charge of one division of the waterworks of Berlin. The Stralau waterworks, as has been shown above, are managed with great skill by Piefke, and consist of an elaborate system of sand filtration, the water being taken from the river Spree. Prof. Fraenkel and Engineer Piefke, incited by an epidemic of typhoid fever which broke out in Berlin in 1889, had come to the conclusion, after careful experimentation upon artificial filters with special bacteria including some of the germs of disease, that, contrary to the general belief, it was possible under certain circumstances for disease germs to find their way through sand filters like those in use in Berlin.‡ Impressed by the importance of their results, they formulated the following conclusions, which they made the text of special addresses at the Public Health Association meeting just mentioned:

I. Every surface water before it is used for drinking ought to be freed from all infectious materials.

II. For this purpose in all those cases in which large quantities of water have to be treated, sand filtration is to be regarded as at present the most practicable and the most satisfactory method.

III. The operation of sand filters is not, as has been widely assumed, always entirely trustworthy and under all circumstances satisfactory. A sand filter is not a germ-tight apparatus, but by intelligent manipulation it is possible to reduce this defect to a very insignificant quantity.

IV. To accomplish this end there are necessary: (*a*) Good raw material (unfiltered water) as little polluted as possible; (*b*) a low rate of filtration; (*c*) uniform action

*The foregoing statements are taken largely from Bertschinger, Wirkung der Sand-Filter in Zürich, 1889. See also Journal für Gasbeleucht. und Wasserversorgung, 1891, p. 684.

†For a full account of the Crenothrix Commission see DeVries's paper, of which an abstract (in English) was published by me in the Technology Quarterly, Vol. III, p. 338, 1890.

‡See Technology Quarterly, Vol. III, p. 69, 1890.

of the filter; (*d*) rejection of the effluent at the beginning of a new period of filtration.

These theses were ably defended by Fraenkel and Piefke at the meeting, but, as might have been anticipated, aroused vigorous opposition. Up to this time it was apparently a common belief among the water superintendents and engineers in Germany that sand filters necessarily removed completely or detained all of the suspended matters of the unfiltered water, not excepting the bacteria. It was with this idea that the Zurich filters were established, and Bertschinger believed that the few bacteria in the effluent from these filters had come from the stones, the underdrains, and outlet pipes, and not through the filter. His ideas probably well represented the state of opinion among water engineers in Germany up to the time of the experiments of Fraenkel and Piefke. They were supported also by the sanitary experience of London, and by English experience in general, for it had been found unquestionably true that filtration was a great sanitary safeguard; but until the experiments of Fraenkel and Piefke no one in Europe had undertaken to discover, by an application of special cultures of known bacteria to sand filters, whether these could or could not be discovered in the effluent.

The experiments of the State board of health of Massachusetts, made in 1889, and published in 1891, were the first experiments of this kind ever made, and they proved conclusively that bacteria may, under special circumstances, pass through sand filters operated intermittently. The experiments of Fraenkel and Piefke were the first which demonstrated the same possibilities for continuous filters.

The allegation that sand filters might not be an absolute surety against the passage of disease germs, aroused a vigorous debate at the meeting referred to in September, 1890, and met with strong opposition. It was urged more or less effectively that the experimental filters of Fraenkel and Piefke, having been made of wood, and the same filter having been run at different rates, their conclusions were based upon abnormal conditions and were untrustworthy. Piefke has since repeated the experiments under conditions adapted to meet these objections, and has obtained results confirmatory of the earlier experiments. The truth seems to be that sand filters if well managed are a complete sanitary safeguard, but that they require intelligent management to produce the highest results. The experiments of the State board of health of Massachusetts, at the Lawrence experiment station have been conducted for a longer time, and with greater care than any experiments elsewhere, or hitherto, and these show conclusively that the results of Fraenkel and Piefke are probably sound. A sand filter is not necessarily a germ-tight apparatus, but it is entirely possible to construct and operate sand filters in such a way as to render filtered water safe for domestic use and for drinking purposes.

The address of Engineer Piefke at the meeting referred to* is full of interesting matter concerning sand filtration. He begins by saying that one of the indispensable requisites for success is that the rate shall remain constant, and not depend upon the variations of the consumption during the day. We may get an excellent illustration of the range of this variation in consumption if we follow hour by hour the history of the water supply of a great city on any particular day. In Berlin, for example, the daily consumption from the two waterworks (Tegel and Stralau) on the 21st of August, 1889, was 120,000 cubic meters or 31,701,600 gallons. The average, therefore, was 5,000 cubic meters or 1,320,900 gallons per hour. The actual consumption per hour varied, however, so much that at midnight it fell 64 per cent below the average, and during the day it rose about one-half above it. The greatest consumption was between 8 and 9 a. m. and 3 and 4 p. m. The smallest between 2 and 3 o'clock a. m. These variations in their range and distribution can be conveniently followed by the help of the diagram (fig. 6) which is self-explanatory. It follows, obviously, that the filters must supply in the night too much, and in the day too little water. It therefore becomes necessary to introduce between the filter and the point of consumption a reservoir in which the excess filtered during the night can be reserved as a store for use during the day, the time of maximum consumption. This reservoir may be called the compensating reservoir.

For Berlin, under the conditions prevailing at that time, Piefke estimated, by an examination of diagrams such as we have just given, that a compensating reservoir of at least 25,000 cubic meters (6,604,500 gallons) actual capacity was required. In fact, the Berlin reservoirs actually hold more than 30,000 cubic meters (7,925,400) gallons, and consist of three quite independent sections, so that if one of them needs to be thrown out of connection the other two may still suffice. Piefke recommends that the reservoir for filtered water should be covered, not only to avoid disturbance through the accumulation of ice in winter but especially to exclude light. In fil-

*The report of this part of the meeting is very interesting, and I have drawn largely upon it in the preparation of this paper. It is to be found under the title, "Filteranlagen für Stadtische Wasserleitungen," in the Deutsche Vierteljahrsschrift für öffentliche Gesundheitspflege, Bd. 33, 1891.

tered waters exposed to the light various algæ and other organisms flourish and affect more or less unfavorably by their growth the water which has been so carefully purified.

Piefke next considers the proper operation of the outflow and inflow of sand filters. There appears to be no special difficulties in the regulation of the inflow by the watchman, for if the filter receives by mistake at any time too much water the excess can escape through the overflow pipe. (See Pl. IV, fig. 2, *u*.) More complex is the management of the effluent in prescribed quantities; this requires the assistance of hydrometric apparatus. Let us suppose that a filter of 2,000 square meters area is required to work throughout a certain period at the rate of 100 vertical millimeters (4 inches) per hour. This will regularly furnish 200 cubic meters per hour. When it is possible to measure and control at any instant the filtered water flowing off it becomes possible to adjust the filter to its duty. A very convenient method of measuring the water is the one in which it is allowed to flow off out of a spacious tank through a horizontal slit in a vertical wall. The slit should have, in proportion to its width, an insignificant height. The quantity of water which escapes through the slit depends upon the height of the water above the upper border of the slit. This we may call the head. Different amounts of head naturally represent special amounts of effluent. If the height of the water above the slit is fixed, then it is evident that the hourly discharge of water will always be the same. For different quantities of effluent corresponding head can be computed, and after this has been once done a scale can be prepared, which, fixed in position, shall instantly show at what point the water level must be in order to obtain a certain quantity of water in a unit of time.

Use is made of this principle in an apparatus which has been much employed for several years under the name of the "Gill" regulator, and which is shown on Pl. V, figs. 3 and 4. From the covered filter, shown on the right of the figure filtered, water passes through the underdrain *c*. Under the gatehouse, at *s*, can be seen the slit through which the water flows out freely; a few centimeters above this is the water level, computed for the normal or desired rate of filtration; it is plainly marked upon a scale, and for control there is a float which rises and sinks in a tube and carries by a chain over a pulley an automatic pencil. The indicator must not leave the place computed for it if the filtration is to be constant. A new and more serviceable form of Gill's regulator permits the filtration and supply to be brought very accurately into relation with one another.

The Gill regulator works satisfactorily and permits the operation to go on at any prescribed rate of filtration, but its use presupposes intelligent service on the part of a watchman. As this may be regarded as an objection, we may turn, says Piefke, to the consideration of automatic regulators. An example of these is that devised by Lindley (see fig. 7) for the recently constructed filter works at Warsaw. Lindley provides each filter with a walled but unpartitioned gatehouse. The filtered water rises in this to the proper height and carries a heavy float. Firmly fixed to the latter is the telescopic tube *b* closed at the top. This naturally shares in all vertical movements of the float, rises and sinks as this does, and thus moves up and down over the fixed tube below, which is open at the top, and is also shown in fig. 7. On account of its fixed weight the float sinks always to the same depth in the water whatever may be the height of the water level in the gatehouse. If now below the level of the float, we make two elongated slits or openings in the wall of the tube; these will keep at a constant depth beneath the surface of the water and always allow the same quantity of water to flow off into the tube. Any variation will occur only in case the slits themselves are changed, which is effected by an external movable ring.

For the maintenance of an even working of the filter it is required further, that for every portion of filter surface which for cleaning or any other reason is thrown out of operation, an equally large area shall be provided as a substitute. The size of the reserve surface involves difficulties which constitute one objection to filtration. Since by cleaning the filter there is removed every time a thin layer of sand, and the sand layer gradually grows too shallow, it must after long use become unfit for further operation and has to be replenished, a task which usually demands several weeks. For this reason also reserve filtering areas should be provided. The surfaces which are provided are usually found successively in different stages of preparation, a part is being cleaned, a part is being worked, and a part is being supplied with fresh sand. Theoretically one may say that the reserve surfaces provided should be three times of the actual filters. Their proportion to the active surface is, however, not constant, but can be discovered only by experience, diminishing obviously with the rapidity of filtration. The objection brought against a low rate of filtration is mainly the financial one. In his recent paper, Lindley has made valuable statements concerning the cost of construction of filter plants. He gives especially the cost in Berlin and Warsaw, and concludes with the following facts: Estimates carefully corrected give for a large establishment of covered filters having 48,000 square meters of filtering area, in round numbers, 67 marks or 84 francs ($16.75)

per square meter. A similar computation for open filters, with the same materials and the same price for labor, showed that these would cost about 45 marks or 56 francs ($11.20) per square meter; that is, two-thirds as much. The covering of filters thus means on the Continent an increased cost of 50 per cent. Lindley quotes the actual cost of the Berlin filter at Stralau at 64 marks and at Tegel 68 to 72 marks per square meter. He cites early English experience as indicating a cost of $10 to $13 per square meter, everything included.

Piefke then proceeds to a discussion on the relative advantages of covered and open filters, and shows that the open filters are more effective from a bacteriological point of view or at least that the output of bacteria from them is smaller. He gives a diagram (fig. 8) showing these facts. The main objection to open filters is that in winter they can not so readily be cleaned, on account of the freezing of the sand, but Piefke claims that by selecting a warm "spell" for cleaning it is quite possible (in Berlin) to avoid complications from this source, and the English experience certainly confirms this idea. It is to be remembered that the consumption of water is much smaller in winter than in summer, and also that the life of the filter is correspondingly longer, owing to the absence of the more bulky vegetable growths of the summer. It seems probable that the greater bacterial efficiency of the open filters is due to their easier clogging, which, of course, signifies a shorter "life."

As has been said above, the addresses of Fraenkel and Piefke provoked much comment, and their views met with considerable opposition. In the course of the debate, Engineer Kummel, director of the waterworks at Altona, introduced some highly instructive diagrams, which are here reproduced in figs. 9 and 10.

More recently Piefke has repeated the experiments upon which his earlier conclusions were based and in such a manner as to meet all objections. The results entirely confirmed those of his previous experiments. There is no reason to doubt that a sand filter is not necessarily and under all circumstances a germ-proof apparatus; but it is equally plain that with proper management it may become germ tight, and that even when not as carefully operated as it should be it is often very nearly germ proof. Its function as a sanitary safeguard is therefore of the highest importance, and that it has already attained great efficiency in this direction vital statistics abundantly prove.

I have already alluded to the fact that we owe to the State board of health of Massachusetts the first proof that bacteria may pass through a sand filter, and to Fraenkel and Piefke the first proof that bacteria may pass through during the continuous filtration of water. More recently the State board of health of Massachusetts has been experimenting at great length upon the removal of disease germs from the water of the Merrimac River as received at the Lawrence experiment station, both by intermittent and by continuous filtration. The results thus far obtained are highly satisfactory, and will soon be made public in the report of the board. I may say, however, that it has already been found possible to remove all the germs of typhoid fever from the water of the Merrimac River by filtration through sand at a rate which readily places this means of purification within the reach of ordinary American cities. I would earnestly recommend to those interested in this subject that they fully inform themselves concerning the important researches in this direction now going on at the Lawrence experiment station of the State board of health of Massachusetts, under the direction of Hiram F. Mills, esq., the distinguished hydraulic engineer, who is a member of the board and chairman of its committee on water supply and sewerage.

Sand filtration of the water supply of London.—I have kept for the last the most important example of sand filtration in the world, namely, that of the public water supply of London. The water supply of London gradually became so objectionable that in 1852 it formed the subject of legislative interference which was destined to have a far-reaching influence, not only upon London but upon the whole of Europe. In this year was passed the now well-known water act, which provided for a metropolitan supply, granting the privileges of such supply to eight private companies, but requiring them to locate their intakes on the Thames above the influence of tidal flow and above the influence of London sewage, and prescribing effectual filtration. A portion of the act runs as follows:

"From and after 31st August, 1855, every reservoir within a distance in a straight line of St. Paul's shall be roofed or otherwise covered over, except storage reservoirs for collecting the water before filtration, and except reservoirs for water used for street cleaning or fires, and not for domestic use.

"From and after 31st December, 1855, every company shall effectually filter all the water supplied by them within the metropolis for domestic use, excepting any water which may be pumped from wells into a covered reservoir or aqueduct without exposure to the atmosphere."

Instead of entering upon a detailed description of the London filters, which would require more space than I can command, I have ventured to reproduce in reduced facsimile one of the monthly reports upon the London water supply, taken

at random, namely, that for May, 1892. This will be found in the Appendix to this paper, and upon pp. 4-7 of the Appendix is given a concise tabulated and comparative statement of the system, its extent, the depth of the filters, the amount of storage capacity, etc., which has seemed to me peculiarly valuable, inasmuch as it gives in great detail a description of the means by which the greatest and probably the healthiest city in the world is served with drinking water, chiefly through sand filtration. The population supplied is now about 6,000,000, and the area of the sand filters employed for London is 109¾ acres.

It ought to be said that the water supply of London is still in the hands of the eight water companies to which it was given in 1852; and, furthermore, that extreme care is taken to secure, as far as possible, the cleanliness of the Thames by a special board, the Thames Conservancy Board, which protects the purity of the water above the intake. By more recent acts these companies are required to submit the filtered water to the examination of an expert chemist employed by the metropolis, though they also employ on their own part other chemists. For many years the chemist the city has been Dr. E. Frankland, from whom a report appears in the facsimile, as does also one from the companies' present chemists, Messrs. Crookes and Odlin.

I have introduced this (reduced) facsimile principally to show the great care and pains taken to secure for London a pure water supply. It naturally follows that the cost is also great. But I am of the opinion that the last place for economy should be in the matter of a supply of pure drinking water, and I believe that the time is at hand when American towns and cities must have pure drinking water at whatever cost. To accomplish this will require in many cases not only increased expenditure but also more expert administration.*

Results of sand filtration.—I have now given some account of the present theory and practice of sand filtration, and it only remains to consider its results. These are so obvious and so important as to challenge our attention and compel our admiration. The most convenient standard that we have for measuring the sanitary effect of a water supply is the mortality of the community from diarrheal diseases. The reason for this is that these are naturally the diseases which contaminate sewage and which might be expected to travel in sewage-polluted drinking waters. Good examples of these diseases are Asiatic cholera and typhoid fever. The eruptive diseases such as measles, scarlet fever, and smallpox, or the throat diseases such as diphtheria, can not be expected to travel so readily in this way. Of all the diarrheal diseases typhoid fever is the best standard for our purposes, and I know of no disease which offers so good a measure of the sanitary condition of a community in respect to its water-supply as this does. If, now, we compare the death rates from typhoid fever of such cities as London and Berlin, having (in great part) river supplies filtered through sand, with those of American cities, such as Philadelphia, Albany, Cincinnati, St. Louis, Lowell, and Lawrence, having similar supplies unfiltered, we shall find a very great difference in favor of filtration. Some of the results of such a comparison are given in a recent paper by Mr. Allen Hazen and myself upon typhoid fever in Chicago.†

From a careful study of the figures and diagrams there given it will appear that London and Berlin compare very favorably with cities having great storage reservoirs, such as New York, and it is a fact that London has a death rate from this disease as low as that of many cities having unobjectionable supplies. I may also refer again to the results of Korosi's studies upon Budapest (see above), while Bertschinger has shown in his latest paper, referred to above, that with sand filtration of its water supply Zurich has become much less affected with typhoid fever. There is no reason to doubt that if Paris could subject the water of the Seine to the sand filtration before delivering it, as it occasionally does, to the citizens for drinking purposes, many deaths in that city from typhoid fever might be avoided.

One of the most striking phenomena of the recent cholera epidemic in Hamburg was the exemption of the closely connected city of Altona. Both are on the Elbe. Both use the Elbe as the source of their water supplies. But in Hamburg the only system of purification is the use (nominally) of settling basins. In Altona the water is purified by sand filtration. The Hamburg system is overworked and the water is scarcely allowed to settle at all. The death rate from typhoid fever has for years been high in Hamburg. During the recent epidemic of cholera Hamburg suffered

---

*Those who wish to read further concerning the water supply of London may consult the following: Quarterly Review, 1892, p. 63; Nineteenth Century, 1892, p. 224; Contemporary Review, 1892, p. 26; Fortnightly Review, vol. 36, p. 378; The Monthly Reports on the Metropolitan Water Supply; The Annual Reports of the Local Government Board. In the paper in the Quarterly Review (which contains much of value) further references will be found. I would also refer the reader upon the subject of filtration to Kirkwood's most valuable report on the Filtration of River Waters, New York, 1869.

† Engineering News, April 21, 1892.

severely, while Altona, though very near it, on the same side and below it on the river, was virtually exempt.

Pl. IX (after Reincke) may serve to give a good idea of the remarkable instance furnished by Hamburg on the one hand and Altona-Ottensen on the other. Fig. 1 shows the general situation of Hamburg, the main sewer outfalls of Hamburg and Altona, and the position of the intake of the Hamburg waterworks. Fig. 2 shows the intimate relations of Hamburg and Altona and also the location of the intake and the sand filters of Altona-Ottensen, some 8 miles down the river at Blankenese. During the cholera epidemic of 1892, Hamburg, with a population of 622,530, had 17,975 cases and 7,611 deaths from Asiatic cholera. Altona, with apopulation of 143,000, had during the same period 562 cases and 328 deaths. The intake of the Hamburg waterworks is about 2 miles above the city, but, it is said, not so far that the flood tide may not carry to it the sewage of Hamburg-Altona. The Elbe at Blankenese contains all the impurities present at the Hamburg intake, plus the sewage of Hamburg and Altona. Yet Altona suffered but little from cholera, while Hamburg suffered severely. The imperial board of health of Germany, in a recent publication, attributes the comparative exemption of Altona to the fact that its water supply was effectually protected throughout the epidemic by sand filtration.

On the other side of Hamburg from Altona lies the city of Wandsbeck (see Pl. IX, fig. 1) with a population of about 20,000. Although it adjoins Hamburg it enjoyed an exemption similar to that of Altona, having had only 64 cases and 43 deaths from the cholera. Moreover, in the case of Wandsbeck and Altona there was every reason to suppose that the cases which did occur were imported from Hamburg, and not due to the local conditions. According to the imperial board of health Wandsbeck is supplied with water, not from the Elbe, but from two inland lakes, the water from which is first subjected to thorough sand filtration and then delivered to the citizens. It is further stated that during the epidemic the sand filters of Altona were carefully watched and were worked at a low speed in order to secure complete protection against the disease.

It is cited by the same authority, as a proof that the Hamburg water supply was infected, that certain streets of Hamburg adjoining Altona were served by the Altona waterworks, and that these streets remained unaffected during the epidemic. So also did a portion of the garrison at Hamburg which used well water of good quality, while another portion, supplied with the Hamburg water, was attacked with cholera. As the very latest example of the beneficent sanitary results of sand filtration, the case of Altona is well worthy of the most serious consideration.

Those of our American cities, such as Chicago, Philadelphia, Albany, Lowell, and Lawrence, which regularly supply to their citizens fecalized water, i. e., water liable to contain bowel discharges, may reasonably feel no small anxiety after the sad experience of Hamburg with fecalized water in 1892.

APPENDIX 6.

REPORT OF A BOARD OF ENGINEER OFFICERS UPON THE FEASIBILITY AND ADVISABILITY OF USING THE WATER POWER OF GREAT FALLS FOR THE PURPOSE OF LIGHTING BY ELECTRICITY THE PUBLIC BUILDINGS, GROUNDS, AND STREETS OF THE DISTRICT OF COLUMBIA, PRINTED IN SENATE EX. DOC. NO. 154, FIFTY-THIRD CONGRESS, SECOND SESSION.

WASHINGTON, D. C., *July 18, 1894.*

Report of a board convened by an order of which the following is a copy:

SPECIAL ORDERS, No. 19. } HEADQUARTERS CORPS OF ENGINEERS, U. S. ARMY, *Washington, D. C., April 19, 1894.*

[Extract.]

1. By authority of the Secretary of War, a board of officers of the Corps of Engineers, to consist of Col. George H. Elliot and Capt. John G. D. Knight, will assemble in this city, on the call of the senior member, to consider and report upon the feasibility and advisability of using water power in the neighborhood of Washington, D. C., for providing electric light for public and private use in the District of Columbia.

* * * * * * *

By command of Brig. Gen. Casey.

JOHN G. D. KNIGHT,
Captain, Corps of Engineers.

By indorsement of April 20, 1894, the Chief of Engineers referred to the board a copy of a resolution of the Senate, dated March 1, 1894, with instructions that it

was not desired that the board should submit a detailed report, but rather a general presentation of the subject, such as would result from a reconnoissance of the ground, etc., and that the report would not include the legal question relating to land and to water rights, but only the engineering problems involved.

The resolution is as follows:

"*Resolved*, That the Secretary of War be directed to investigate and report to the Senate the feasibility and advisability of using the water power of the Great Falls of the Potomac, or any other water power in the neighborhood, for the purposes of lighting by electricity the public buildings, grounds, and the streets of the District of Columbia. Said report shall suggest the method by which the right to use said water can be acquired and what steps should be taken, by legislation or otherwise, to acquire said water power and the land needed adjacent thereto; also a general plan of the electric plant needed at said falls and of the wires needed between said plant and the different parts of said District, and an estimate of the cost; also, whether said power will probably be sufficient to furnish light to private consumers within said District, and suggestion of the terms and regulations under which it shall be furnished."

By letter of April 27, 1894, the Adjutant-General of the Army directed First Lieut. Samuel Reber, Signal Corps, to report to the president of the board for such duty as the latter might require; and the board desires now to acknowledge its indebtedness to that officer for valuable services relating to, suggestions of, and estimates for hydraulic and electric plant.

The board met April 24, 1894, and on subsequent days, and visited Great Falls, having examined the Virginia and Maryland banks of the Potomac River above, at, and below the falls, and also the Chesapeake and Ohio Canal level above Seneca Falls, 8 miles above Great Falls.

It is of the opinion that it is both feasible and advisable to use the water power of the Great Falls for the purpose of lighting by electricity the public buildings and grounds, and the streets of the District of Columbia.

The board bases these conclusions on a study now to be indicated.

THE WATER POWERS IN THE VICINITY OF WASHINGTON.

The Little Falls.—The Little Falls are about 4½ miles above Washington. The fall, as we find in a drawing based on the surveys made in 1852 under the direction of the late Gen. M. C. Meigs, then a lieutenant in the Corps of Engineers, U. S. Army, is about 35 feet in a distance or about 1¾ miles.

The greatest freshet in the river of which there is authoritative record occurred June 2, 1889. The river rose at Chain bridge, just above the foot of the falls, to 43.3 feet above tide level, and remained within 3 feet of that height for about twenty-four hours, and within 6 feet for about thirty hours. In other words, for about thirty hours the river at the foot of Little Falls was above the low-water level at the head of these falls. During this freshet the river rose to a height of 16 feet above the crest of the dam at Great Falls.

In November, 1877, there was another great freshet, in which the river rose to a height of 12 feet above the crest of the dam at Great Falls, which then extended only to Conns Island, across the Maryland channel, the Virginia channel being unobstructed. No record is available of the corresponding height in the vicinity of Little Falls.

It is recorded that in 1852 the river at Seneca Creek, which is about 8 miles above Great Falls, lacked but 8 inches of reaching the height it attained in 1877.

These facts lead to the conclusion that any plant established to utilize the power at Little Falls would have been practically inoperative during a period of at least thirty hours in June, 1889, probably inoperative both in 1877 and 1852, and that the variability of the water power in this vicinity is too great to justify relying upon it for the purpose under consideration.

The Great Falls.—The Great Falls is a series of rapids in the river, extending about 2,000 feet, in the course of which the river falls about 76 feet. They are about 14 miles above Washington. At the head of the falls is the dam of the Washington Aqueduct, 2,877 feet long, extending across the river from the Maryland to the Virginia shore. From a point on the Maryland side of the river, and just above the dam, leads the Washington Aqueduct, the upper portions of which are mostly in tunnel.

FEASIBILITY.

In answering the question as to the feasibility of using the water power at Great Falls for lighting, by electricity, the public buildings and grounds and the streets of Washington, we must first know whether electrical power can be transmitted so great a distance, whether it is practicable to construct a power canal around the

falls and a power plant below the falls, the amount of power available, and the amount of power that will be required.

The distance to which electrical power can be transmitted.—Messrs. Houston and Kennelly, of Philadelphia, recently made an estimate of the distance to which Niagara water power can be economically transmitted by electricity, and in connection therewith stated that "under ordinary conditions the commercial limit of electrical transmission of power from waters of less than 500 kilowatts (670-horse power) can hardly exceed 50 miles," or about three times the distance involved in the case now under consideration. To-day 2,000-horse power are transmitted from the falls at Tivoli, 18 miles, over the Campagna to Rome, where part is used for arc-lighting of streets and the remainder distributed for use in houses.

Electricity generated by machinery actuated by the water power of the falls of the Willamette River is transmitted 13 miles to Portland, Oreg., where it is applied to lighting. Furthermore, July 13, 1893, a committee, composed of Profs. George Forbes and W. C. Roberts-Austen and Col. J. Pennycuick, of the Royal Engineers, reported on the utilization of water power at the Perriya irrigation works in India. This committee, after considering the relative cost of this power and of steam power, reported that there would seem to be every probability that a large portion of the available water power could be profitably used at a distance of 350 miles from the works.

We therefore find that electrical power can readily be transmitted from Great Falls to Washington.

Sites for a power canal and a power plant.—The Maryland side of the river at Great Falls is rocky and precipitous, and the only available place for a canal on this side of the river is occupied by the Chesapeake and Ohio Canal. On the Virginia side the foot of the hills is somewhat retired from the shore of the river, leaving a kind of plateau extending from above to below the falls. Through this plateau passed the batteaux canal, constructed in 1785, of the old Potomac Company, of which Gen. Washington was president, and of which portions of the bed and the locks still remain. Our examination of the locality leads to the conclusion that, while the construction of a power canal and a power plant on the Virginia side of the river would not be free from difficulties, it may be accomplished within a reasonable cost.

The amount of power available.—While no series of measurements of the flow of the river in the vicinity of Great Falls or profiles of the river in floods at that place are available, there is a record of the height of the river on the dam immediately above the falls, which record is almost continuous since the completion of the dam in 1886. The flow can not be mathematically connected with the recorded heights, but may be approximately. In 1856, the river being at an unusually low stage, Mr. W. R. Hutton, C. E., assistant engineer to the late Gen. Meigs (then captain), determined by measurement the flow at a favorable place below Great Falls to be 1,065 cubic feet per second, which measurement was accepted by the Court of Claims in a suit of the Great Falls Manufacturing Company against the United States as the minimum flow of the river at that point. From several years' observations the records of the Washington Aqueduct show that at the lowest stages of the river the water at the gauge above the Great Falls dam is 0.5 foot higher than the crest of the dam.

It is assumed, then, that when the gauge reads 0.5 foot the flow of the river is at the rate of 1,065 cubic feet per second.

Let it be assumed that 75,000,000 gallons per diem will (until another conduit be constructed) be the maximum amount of water that will be required for water supply to the District of Columbia. Seventy-five million gallons per diem are equal to 116 cubic feet per second. The amount of water at low water available for power will then be 1,065—116=949 cubic feet per second. If it be assumed that the available fall of the river at Great Falls is 70 feet, the number of horse powers available at the lowest stages is 7,524, and taking 0.85 as the efficiency of turbines, the power of a series of turbines below the falls at the lowest stage of the river would be 6,395-horse powers.

The quantity of water flowing over the dam available for power below the dam and also the number of horse powers vary in proportion to the square root of the cube of the height of the water on the dam. Assuming 1,065 cubic feet per second to be the flow corresponding to a river height of 0.5 foot above the dam, the flow corresponding to the recorded heights for the two fiscal years ending June 30, 1892, and June 30, 1893, has been computed and also the corresponding number of horse powers that would have been effective on turbine shafts below the falls. The former year may be considered an average year as regards low-water flow; the latter was a year of extraordinary low water. For six days in the year ending June 30, 1893, this horse power would have been 6,395; for seventy-three days in this year and seventeen days in the previous year it would have been 8,648. The corresponding gross horse powers are 7,524 and 10,175, differing by 2,651. This difference corresponds to a flow of 375 cubic feet per second. Were this additional flow provided

for during the period of low water, the effective horse power would be increased from 6,395 to 8,648.

Seven and a half miles above Great Falls, and near the mouth of Seneca Creek, a site seems favorable for the construction of a low dam, behind which there could be provided a reservoir area of about 2.5 square miles without overflowing the river banks, and of about 8 miles adjacent lands be submerged. If this greater extent were utilized it would be necessary to raise the banks of the adjacent canal and strengthen the arches of the culverts under it. With every foot in depth of water stored in this reach of the river the low-water flow at Great Falls could be increased to a flow corresponding to 8,648 horse power for about two and two-tenths days, so that it may be possible to provide sufficient storage to tide over periods of extreme low water by a dam so low as not to cause the banks above to be submerged, possibly by a movable dam, which, when lowered, would exercise no deleterious influence on property above by backwater in times of freshets.

Further study of this subject of storage should be accompanied by surveys and velocity measurements, for which, and other purposes, no funds were at the disposal of the board. Until such study be made it is prudent to consider that only 6,395 horse power would be available at turbine shafts below the falls, and that this amount may possibly be increased by storage to 8,648.

The amount of power required.—It has been found impossible to arrive at an exact determination of this amount. Gas and electricity, sometimes one, sometimes the other, or both, are in actual or contemplated use, but the numbers of gas-burners or of electric lamps, or of electric lamps that should replace burners, and the numbers of hours of service of such lamps are not readily to be determined. Fortunately it has been possible to obtain from Chief Engineer Thom Williamson, U. S. Navy, superintendent of the State, War, and Navy building, the hourly records of the electric service in that building and other data relative to its lighting by both gas and electricity. From these records some idea has been formed as to the load of an electric plant required for lighting Department buildings, and from other data some guide has been obtained for an estimate of the number of electric lamps required to replace burners in these buildings. Data has also been obtained relative to the lighting of the White House, nearly all the Department buildings, and other public buildings and the public grounds.

The following estimates for street lighting are based upon data obtained from the annual reports of the operations of the engineer department of the District of Columbia, and from statistics of May 31, 1894, kindly furnished by Capt. Powell, the Engineer Commissioner of the District of Columbia:

	Lamps in service.			Yearly hours of service of gas lamps.
	Gas.	Oil.	Arc (actual 1,000 candle power).	
June 30, 1880	4,048	....	....	2,200
June 30, 1893	5,954	700	332	3,000
May 31, 1894	6,246	747	327	* 3,900

* Recommended by the Commissioners of the District of Columbia.

Where arc lights have been substituted for gas in the District service, 1 arc light has replaced 2.08 gas lamps. But this high ratio would not probably be maintained throughout the District, and in estimating for future needs, the ratio of 2.5 gas lamps to 1 arc lamp has been used. Under this assumption 3,124 arc lamps are required for the present street service, and if the area to be ultimately lighted is taken as double that which is now densely lighted, the conclusion is reached that 6,340 arc lamps will then be required.

The following is a table of the electric lamps now required for public needs:

	Incandescent (16-candle power).	Arc (actual 1,000-candle power.)
Streets		3,124
Capitol grounds		75
Public grounds		82
Departments:		
Treasury	3,700	
Justice	300	
Post-Office	2,000	
Interior	3,200	
Agriculture	685	
District buildings	2,400	
Washington barracks	500	30
(*a*) Individual steam plants in use for partial lighting:		
Capitol	7,150	
White House	1,350	
State, War, and Navy building	2,400	
Department of Agriculture	200	
Public Printing Office	4,600	
(*b*) Individual steam plants now available for entire service:		
Congressional Library	8,000	
Washington Monument	98	
Total	36,583	3,311

To determine the horse power required for the above service, which includes all of the public buildings, grounds, and streets of Washington, it is assumed that each 16-candle power incandescent lamp will require 64 watts and each arc lamp 450 watts; that 83 per cent of power at the turbine shafts is effective for incandescent lights and 68 per cent for arc lights, and that four-tenths of the maximum incandescent load may be required at the same time as the full arc load. Under these assumptions 4,458 horse power should be available at the turbine shafts for generating the electricity required for the lights above tabulated, which is 0.70 of the horse power which may be made available without storage at the lowest river stage. The remaining 30 per cent, or 1,937 horse power, can for the present be used for pumping from the United States mains to the high-service area of the city and for other public purposes.

We find, then, that electrical power can readily be transmitted from Great Falls to Washington; that there can be constructed, at reasonable cost, a power canal around the falls and a power plant below them; that there are available at the lowest stages of the river 6,395 horse power, without storage of water above the falls in the Seneca reach of the river, and 8,648 horse power with such storage, while 4,458 horse power only are required for the present lighting purposes; and we therefore come to the conclusion that it is entirely feasible to use the water power of the Potomac at Great Falls for the purpose of lighting the public buildings, grounds, and streets of the District of Columbia.

It may be remarked in this connection, that eventually 3,216 additional arc lights will be required for lighting public grounds and streets, calling for 2,853 horse power, and that the lighting of public grounds and streets alone will then require practically all the power available without storage.

Groups (*a*) and (*b*) of the table above consist of buildings whose partial or entire lighting is provided for by electric plants operated by individual steam plants already provided. Should none of the water power be applied to their lighting, 2,920 horse power will, for the immediate present, be available for other purposes mentioned above.

But during the past fourteen years the number of street lights in use in the District has doubled. As the increase continues, a time will arrive when the available water power will not suffice for the lighting of all the streets and the public buildings and grounds. Auxiliary steam power will then be necessary. The most economical application of this power will be, not to the lighting of streets, involving the expense of conduits and mains, but to the lighting of buildings, for in these buildings the steam plants may be located and utilized at the same time for motive power or heating, while the losses of transmission and the cost of conductors will be minimized. In the end but one-tenth of the water power will be in excess of the needs for street lighting alone, and this would not be an unreasonable reserve.

ADVISABILITY.

The question of the advisability of using the power of the Potomac at Great Falls for the public purposes mentioned in Senator Manderson's resolution depends on the present cost of lighting the public buildings and grounds, and the streets of Washington as compared with the probable cost of lighting under the proposed system,

and also on the probable cost of the works required for the latter system and the probable cost of operation.

The cost of lighting under the present system and the probable cost under the proposed system.—During the year ending December 31, 1893, the city of Chicago operated 1,110 arc lamps from 4 power stations at an average cost of $96.64 per lamp per year, using steam power and underground circuits. This cost does not include interest, depreciation, or taxes. The entire cost of land, buildings, plant, dynamos, lamps, posts, conduits, circuits, and all the other items charged to construction December 31, 1893, was $688,312.80.

The mayor and board of public works of Evansville, Ind., reported February 28, 1894, to the common council of that city upon the feasibility of the city owning its own electric plant. This report contains a list in which are to be found 16 cities, besides Washington, using 300 or more arc lamps. Thirteen are lighted by private contract at an average yearly cost per lamp of $111.12, St. Louis being furnished 2,000 arc lamps at a charge of $75 per lamp. Three cities own and operate their own plant at an average cost per lamp of $85.62, the cost in the case of Wheeling, one of the three, being $62 per lamp for 400 lamps.

June 20, 1894, contracts for lighting some of the streets of the city of Baltimore with electricity were awarded at $127.75 per arc lamp per year. But two bids were received, one for the eastern district, the other for the western district. The partition of the city was made by the companies bidding, which thus avoided the risk of one underbidding the other and enabled both to secure the maximum price for lighting service fixed by ordinance. One company furnishes 635 lamps, the other 404.

At present the yearly charge to the District for each arc lamp is $182.50.

From these figures it is apparent that this city is paying far above the average charge for arc lights, and about double the cost of such lighting to cities owning and operating their own plant. The figures given are based upon the use of steam plant with its expensive coal consumption.

Estimates which are given herewith have been made of the cost of operating a system actuated by the water power of the falls, and they give $52.33 for the cost per arc light per annum.

It has been assumed that each arc light would replace 2.5 gas burners. The present contract price for each gas lamp per year is $21.50; and at this rate the annual cost for two and a half lamps would be $53.75. The estimated annual cost of an arc light is therefore about the same as the annual cost of the gas burners it would replace.

The advantage in using the water power of the Great Falls for lighting the streets and grounds of the District will be the increased amount of light afforded for the same annual expenditure.

From the foregoing the board concludes that it is advisable to use the water power at Great Falls for the public purposes indicated in the resolution.

GENERAL PLAN OF PLANT.

The general plan of the plant needed may be outlined as follows: Vertical turbines directly coupled to comparatively low-tension alternating-current generators. The potential of the current to be raised by transformers to 10,000 volts and transmitted by an aerial line to the city limits and thence to a convenient distributing station in Washington, by underground cables, and there utilized to actuate polyphase motors. These motors to be mounted on shafts, to which shall be coupled armatures of direct-current dynamos, each generating unit to be for 100 or 125 lights.

Without surveys it is not practicable to furnish an estimate of the cost of constructing the canal, but an approximate estimate of the cost of all hydraulic and electric plants, buildings, aerial line, conduits, and lamps is $3,764,930. This is for the utilization of that part of the water power of the falls which is deemed available without resort to storage, i. e., 7,524 gross horse power, or 6,395 at the turbine shafts.

This power, even if increased by resort to storage, will not be sufficient to furnish light to private consumers.

Estimate of cost.

Hydraulic plant of 12,800 H. P.*	$64,000
Building for same	51,200
Electric plant	109,710
Aërial line	102,150
Distribution plant	250,000
Building for same	20,000
Cable for mains and lamps	492,600
Conduits	2,250,000
Lamps and standards	424,970
	3,764,930

* For the reason that the available hydraulic head is liable to be reduced about one-half in times of freshets the plant estimated for is correspondingly increased.

Estimate of cost of operating expenses.

Hydraulic plant:		
Repairs, 12,800 H. P., at 57 cents	$7,296	
Attendance and supplies, at $1.44	18,432	
		$25,728
Electric plant:		
Repairs, 4½ per cent	4,388	
Attendance and supplies	9,720	
		14,108
Aërial line:		
Repairs, 1½ per cent	1,534	
Attendance	6,480	
		8,014
Distribution plant:		
Repairs and supplies, 6 per cent	$16,200	
Attendance	12,240	
		$28,440
Cables:		
Repairs, at 10 per cent		49,280
Conduits:		
Repairs, at 1½ per cent		33,750
Lamps and standards:		
Repairs at 8 per cent		34,000
Administration		10,000
Expenses for 6,527 arc lights		203,300
Expenses for one arc light		31.10
Add for attendance		14.46
carbons		6.77
Total expenses per annum for one arc light		52.33

It should be remembered that the above estimates are for a plant capable of utilizing the entire power of the falls without resort to storage, and sufficient for lighting all of the probable future area of the city.

To these estimates should be added the cost of lands, of canal construction, and of annual repairs of canal.

If the plant be limited to the present needs of the city, including the public buildings and grounds and streets, the estimated cost of plant so limited, and not including the cost of wiring buildings, is $2,441,030, and the estimated annual cost of operating the same is $201,790. As far as can be ascertained from the data furnished the board, the expenditure for the year ending June 30, 1893, for the above lighting was:

For gas and oil	$187,991.31
For electricity from plant not owned by the United States	77,198.24
For electricity from United States plant	29,968.25
	295,157.80

METHOD BY WHICH THE RIGHT TO USE THE WATER POWER AT GREAT FALLS CAN BE ACQUIRED, AND WHAT STEPS SHOULD BE TAKEN BY LEGISLATION OR OTHERWISE TO ACQUIRE SAID POWER AND THE LAND NEEDED ADJACENT THERETO.

The three riparian owners at Great Falls are the Chesapeake and Ohio Canal Company, the Great Falls Manufacturing Company, and the United States. The lands of the Chesapeake and Ohio Canal Company are mainly cut off from the channel of the river by the interposing lands of the United States, and the proportion of its ownership in the power of the falls must be very limited. The Great Falls Manufacturing Company claims the "Toulson tract," on the Virginia side of the river, through which a power canal around the falls would have to pass and on which, below the falls, buildings containing hydraulic machinery would have to be constructed. It is also owner of Conns Island, above the falls, which island is the basis of claims still pending against the United States for damages to the water rights of the company. The United States is the owner of several pieces of riparian property at the falls, and although the proportions of the water rights at the falls belonging to the respective riparian owners have never been determined, judicially or otherwise, it appears to be certain that the United States is by far the largest of these owners.

There is now pending in Congress a bill (S. 1359 and H. R. 7280), of which a copy is transmitted herewith, entitled "A bill to amend an act approved July 15, 1882, enti-

tled 'An act to increase the water supply of the city of Washington, and for other purposes.'" The bill provides for the acquisition by the United States, by the right of eminent domain or otherwise, of all the lands and water rights at Great Falls not now owned by the United States. It has been favorably reported by the Senate Committee on the District of Columbia (copy of report also herewith), and it appears to provide a fair and equitable method by which the water rights referred to can be acquired.

RECOMMENDATION.

For the reason that there were no funds provided for the use of the board, none of the surveys required for determining the location of the power canal and power plant at Great Falls that would be required for utilizing for electrical purposes the power of the falls now wasted and the cost of these works could be made.

This cost, the cost of the necessary works in this city and of the line connecting the two systems, will be so considerable that they should not be undertaken before plans have been very carefully and elaborately worked out, and the board therefore begs to suggest that to this end there be enacted a provision of law similar to the one contained in the District appropriation act of August 6, 1890, which authorized the appointment by the President of a board of electrical, etc., experts, to consider the location, arrangement, and operation of electric wires in the District of Columbia; and the board also suggests that there be immediately appropriated the sum of $10,000 to meet the expenses of the said board.

GEORGE H. ELLIOT,
Colonel, Corps of Engineers.
JOHN G. D. KNIGHT,
Captain, Corps of Engineers.

APPENDIX C C C.

IMPROVEMENT AND CARE OF PUBLIC BUILDINGS AND GROUNDS IN THE DISTRICT OF COLUMBIA—WASHINGTON MONUMENT.

REPORT OF COL. JOHN M. WILSON, U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

OFFICE OF PUBLIC BUILDINGS AND GROUNDS,
Washington, D. C., July 7, 1894.

GENERAL: I have the honor to submit the following report of operations upon public buildings and grounds under the Chief of Engineers during the fiscal year ending June 30, 1894.

In addition to these duties, I am a member of the Light-House Board, and in charge of the erection of a monument to mark the birthplace of Washington and of an iron pile wharf at the mouth of Bridge Creek, Virginia.

PUBLIC BUILDINGS.

EXECUTIVE MANSION, GREENHOUSES, AND STABLE.

In addition to the usual care extended to the mansion and its furniture, the following work has been accomplished during the year:

The tin roof has been repaired and painted, wooden walks and steps leading to flagstaff repaired, and the iron tank on the roof and in the attic cleaned and painted. A large new storage closet has been constructed in the attic and the attic floor repaired where necessary. The elevator has been overhauled and tested and the large elevator tank cleaned out and painted.

The woodwork in the bed rooms, office rooms, corridors, reception rooms, parlors, dining room, and butler's pantry has been repainted and revarnished where necessary and a new copper-lined sink placed in the butler's pantry. The entire heating apparatus has been overhauled and put in complete order and all chimneys properly cleaned.

All gas and electric light chandeliers have been overhauled, cleaned, and repaired where necessary. Portions of the basement, the north area, and the walls, arches, and columns under the conservatory have been calcimined.

The large cistern at southeast corner of mansion, containing 2,400 gallons of water, was emptied and cleaned, two cart loads of mud having been removed. The water-filter has been overhauled and improved, and the tubs and water supply of the laundry were placed in good condition.

The red parlor has been redecorated, the pine trimmings replaced with mahogany, east window cut down to level of floor, new carpet laid, new curtains hung, and furniture reupholstered. New carpets have been placed in four bedrooms and on the stairs leading from lower corridor to the bedrooms; new curtains have been placed in two bedrooms and in the window at west end of upper corridor; new portières at four doors and at the division in upper corridor, and new window shades in the east room, in the red, green, and blue parlors, state and private dining rooms, and in two bedrooms.

In the autumn of 1893 all carpets were relaid and curtains rehung, and in the spring the carpets, amounting to about 3,000 yards, were taken up, cleaned, and stored; curtains taken down and stored; about 1,000 yards of new matting laid to replace old and worn-out material, and the house placed in summer costume. New linoleum was placed on the floor of the corridor between main vestibule and east room.

The north and south balconies and the north front of the mansion from the water table to area floor were painted. New granite steps were constructed leading to the area at the northwest entrance. The columns at the main carriage entrances on Pennsylvania avenue and those of the area railing on the north side of the mansion were repainted.

Considerable work was done to the conservatory and other greenhouses, all of which were overhauled and placed in as good repair as funds would admit; the conservatory was repainted inside and out. All boilers, furnaces, stoves, pipes, chimneys, etc., were cleaned, repaired, and placed in as good order as possible.

Attention is respectfully invited to the conservatory, the frame of which is of wood, rapidly decaying, and almost in a dangerous condition. A new iron superstructure is absolutely necessary, and an estimate of $13,000 is submitted for the work; if deemed best this could be made in two separate appropriations, one of $8,000, for the east section, and the other of $5,000, for the west section. If a new iron superstructure can be constructed, it will last many years with but trifling repairs and thus save the necessity for the annual appropriation of $2,000 for the repair of the present decayed one.

Necessary attention was given to the valuable collection of plants in the greenhouses, a large number of bedding and greenhouse plants propagated, and about 16,000 spring flowering bulbs purchased for the greenhouses and grounds. During the summer of 1894 it is proposed to rebuild the superstructure of the south section of the camelia house.

Extensive repairs were made to the stable; roofs, gutters, and downspouts were repaired and painted, stalls renewed or strengthened, and new floors laid; the roof covering the area between the wings of stable, which collapsed from the weight of snow, was replaced in position, strengthened with columns properly braced, tin covering repaired, new wooden walks placed upon it, and the whole repainted.

I respectfully invite attention to my report for 1893, in which I urged the importance of providing suitable offices outside the Executive Mansion for the President of the United States.

Surely the people of this great nation can afford to provide for its Chief Magistrate, outside of his home, a place where the immense business incident to his exalted position may receive attention.

Congress, in its wisdom, over forty years ago, made provision for the enlargement of the Capitol by the construction of new wings, on account of the growing business of the country, and again within a few years has ordered the erection of a magnificent library building, so that the Congressional Library might be removed from the Capitol.

No steps, however, have been taken for enlarging the Executive Mansion, which to-day, with the exception of interior and exterior ornamentation and improvement, remains as it was when first occupied by President Adams at the beginning of the present century.

It is a fact well known to all that the enormous crowds assembling at official evening receptions, as well as the demands for more rooms for the entertainment from time to time of the nation's guests, long since required either the enlargement of the White House or the transfer of the office rooms of the President to some convenient locality.

Efforts to enlarge the mansion have failed, and again I earnestly suggest that a structure suitable for office purposes shall be provided at an early day, either east or west of the main building, and opposite the Treasury Department or the State, War, and Navy building. If erected opposite the Treasury building, it could be connected by a wide corridor, with a large conservatory arranged as a winter garden, thence into a picture gallery opening into the east room, and thus serve a double purpose, by relieving the mansion of the terrible crush incident to the evening official receptions which take place during the winter.

I earnestly hope that Congress will give this important matter speedy attention, so that, if possible, the new structure may be completed at least by the spring of 1897.

WASHINGTON NATIONAL MONUMENT.

Every effort has been made during the year to maintain the monument and its machinery in good condition.

Vandals continue to give annoyance by occasionally chipping pieces either from the outside or from the memorial stones in the inner walls, while some insist upon writing their names upon the white marble; whenever detected these thoughtless persons are arrested, but, as a rule, when brought to trial escape with a small fine.

The elevator and all the machinery connected therewith has been carefully and critically inspected monthly by an expert from the Otis Elevator Company, and pronounced in excellent condition. Weekly inspections are made by the principal steam engineer and machinist at the monument, and daily tests of the safety appliances of the elevator car are made by the employés before starting to convey passengers to the top.

It is believed that the elevator is as safe as it is possible for man to make it, and every effort is made to prevent accident. Should an accident ever occur it will result from something which it was impossible to foresee.

During the summer and autumn of 1893 the floor of the coal vault was relaid, the steam pipes in the tunnel were repacked and put in good condition, and the boilers cleaned, the side walls and ceiling of engine room were sheathed with plank, and a new wire governor rope placed in position, the old rope being used to replace a worn-out hand rope.

On January 1, when the boilers were opened for cleaning previous to trying automatic cleaners, a scale about a quarter of an inch thick was found on some of the tubes and on the shell of the boilers, while the tubes were covered with mud and slime.

Two Obenchain automatic boiler cleaners were attached to the boilers on three months' trial and gave considerable satisfaction. At the end of the three months they succeeded in removing the slime and mud that had accumulated, and the boilers were found in a comparatively

clean condition; the old scale had been softened to such an extent that it was easily removed. The result was so satisfactory that the cleaners were purchased.

In April the steam pipes in the tunnel were lined up, some new saddles placed in position, the boilers overhauled and painted, the entire machinery of the elevator and electric-light system examined and put in complete order, and the elevator cage repainted. In June, 1894, a portion of the iron between the top and bottom of the shaft was repainted.

The monument was open daily during the year, except Sundays and holidays, and, with the exception of a few days in the autumn and again in the spring while the machinery was being overhauled, the elevator was in operation whenever the monument was open.

There were 148,917 visitors to the top of the monument during the year, of which number 109,579 made the ascent in the elevator and 39,338 by the stairway, making 938,419 persons who have visited the top since the shaft was opened to the public October 9, 1888.

BUILDINGS OCCUPIED AS OFFICES BY THE WAR DEPARTMENT, EXCEPT STATE, WAR, AND NAVY BUILDING.

Under date of June 30, 1893, this office was charged with the preservation, care, and safety of the following buildings:

Army Medical Museum.

Fifth and sixth stories Union building, G, between Sixth and Seventh streets, occupied as offices by Record and Pension Bureau.

Ford's Theater building.

Annex to Ford's Theater building.

Building in rear Ford's Theater building.

Upper stories of West End National Bank, occupied as offices by Signal Department, U. S. Army.

No. 610 Seventeenth street, occupied as offices by Record and Pension Bureau.

No. 1725 F street, occupied by War Department printing office.

No. 1744 G street, occupied by Rebellion Record Office.

No. 1814 G street, occupied by Medical Department, U. S. Army.

Annex to Winder building, occupied for storage purposes by Ordnance Department, U. S. Army.

War Department stables.

A careful and critical examination was at once made of all these buildings, and plans prepared, showing the safe loads that could be carried by each floor of each building.

Where the floors were overloaded the weight was at once reduced to the safe load.

The upper floors of the West End National Bank building were strengthened by beams and girders, and made absolutely safe for all loads that will probably be placed upon them.

In No. 610 Seventeenth street the main stairway was strengthened, where necessary, by iron beams set into the walls.

In No. 1725 F street the floor of the printing-press room was strengthened by wooden beams and columns.

In the Winder Building annex the floors were properly strengthened by placing some new posts in position.

The work done at Ford's Theater was quite extensive, and will be reported under separate heading.

At the close of the fiscal year all the buildings in charge of this office were in safe condition.

FORD'S THEATER BUILDING.

This building was placed in my charge on June 30, 1893, three weeks after the collapse of a portion of it had taken place.

The building is three stories high, with an unfinished loft above the third story and a cellar under a portion of the first floor; the roof is of slate, supported by timber trusses.

The dimensions of the first floor are 103½ by 67½ feet.

The second and third floors are supported by iron columns and beams. Prior to the collapse the first floor, to within 20 feet of the west wall, was supported by brick arches; of the portion so supported, the rear half had a cellar under it, the floor of which was about 7 feet below the springing lines of the arches; the front half had no cellar, the surface of the earth being from 1 foot to 18 inches below the springing lines of the arches.

Previous to June 9, 1893, before the building was placed in charge of this office, certain plans for improvements were ordered, necessitating an extension of the cellar, the prolongation of the central basement arch to the west wall, the construction of a basement entrance from Tenth street, and the underpinning of about 80 linear feet of brick wall, four piers supporting iron columns and the two heavy piers of the west wall. During the progress of this work, under contract, while one of these brick piers was being undermined, it collapsed, bringing down with it two columns from under the second floor, two from under the third floor, and about 40 feet square of each floor, badly wrecking the interior of the building.

By the act of Congress approved September 7, 1893, an appropriation of $6,000 was made for repairing this building, and by letter from the Chief of Engineers, dated September 14, 1893, I was placed in charge of the work. Operations under my direction were commenced on September 20, 1893, at which time the condition of the building was as follows:

The first floor was totally wrecked for an area of about 20 by 14 feet, this being immediately over the new portion of the cellar which had been excavated, over which it had been intended to extend the central basement arch. Of the two piers that had supported the columns on the east side of this opening, the one that failed was entirely demolished, the other was still standing, although its line of columns had been dragged down in the collapse.

The underpinning of walls and piers in the extension of the cellar had been done in a very slovenly manner; the materials were of good quality, but the workmanship very inferior.

The collapse of the brick pier had brought down four cast-iron columns, twelve 12-inch iron girders, and thirty-three 9-inch iron beams from the second and third floors, making an opening in each of these floors about 40 feet square.

The inner face of the west wall, where the floor beams had been torn out, was shattered and cracked, while the upper section of the brick wall around the stairway had been almost torn from the lower section by the strain in falling of a pair of heavy beams resting in the wall; the line of columns on the north side of the openings through the floors was in a dangerous condition, apparently ready to fall at any moment, while portions of brick arches were hanging without other support than the mortar which held the bricks together.

The project adopted was to restore the building to the condition in which it was at the time of the collapse, to complete the extension of

the cellar, the construction of the central arch, the underpinning of cellar walls and piers, and to arrange for a large cellar window on the west side for light and ventilation.

The preliminary operations consisted in tearing down dangerous brickwork, shoring places where necessary, and cleaning away débris; the underpinning of walls completed previous to June 9, wherever defective, was torn out and rebuilt; the two piers on the east side of the cellar excavation were rebuilt upon concrete foundations, brick walls placed on each side of cellar extension, arches properly turned, large cellar window constructed, loosened portions of west wall torn out and carefully patched, and wall around stairway from third story up torn down and rebuilt.

Upon the completion of basement and side walls brickwork the iron columns and beams were reset, additional steel beams having been purchased to replace those bent and twisted by the collapse; all arches were turned and covered with concrete, Georgia pine floors laid in the new portion of cellar and on first and second floors, and the tiling relaid on third floor.

Windows and doors were reset, gas and steam pipes placed in position and tested, walls plastered, the rebuilt portion painted, and a portion of the cellar dug out for a storage room for refuse. Operations were practically completed December 31, 1893, and the building, which was restored to the condition existing previous to its collapse, with some additional improvements, was ready for occupation, and in my opinion was in as safe condition as it had been since its original construction.

For complete details of this work between September 20 and December 31, I invite attention to the interesting and elaborate report of Second Lieut. John S. Sewell, Corps of Engineers, my assistant, who has exhibited in the discharge of his duty connected with the repair of this building the utmost energy, skill, industry, and ability.

In accordance with the terms of the act approved September 7, 1893, a board of engineers was convened in November, 1893, to examine Ford's Theater building and to report whether its condition was such that it could be safely occupied by clerks.

This board, under date of December 30, 1893, recommended that the floors should be strengthened with iron columns and girders, the east wall taken down and rebuilt, the lighting and ventilation of building improved, and fire escapes constructed; the estimated cost of the proposed work was placed at $11,958.

By the act of Congress approved March 12, 1894, an appropriation of $11,958 was made for the improvements recommended by the Board of Engineers, and under date of March 24, 1894, by direction of the Chief of Engineers, the work was placed in my charge.

Operations were commenced on March 31, the work to be done being as follows:

1. To strengthen the second and third floors by additional lines of girders and columns placed running north and south along middle lines of existing panels: the columns under the third floor to be supported by columns under the second floor, resting on brick piers in the basement; the girders under both floors were to be 10-inch I-beams (doubled); the columns under the third floor were to be of ¾-inch metal and 6 inches in diameter, and those under the second floor of 1-inch metal, 7 inches in diameter; the brick piers were to be 2 feet 6 inches by 2 feet 6 inches, resting on concrete bases 4 by 4 feet by 1 foot 6 inches.

The result of this work will be to strengthen the building so that in addition to their dead weights the second and third floors will sustain a live load 122½ pounds and 71 pounds respectively.

2. To tear down and rebuild the east wall, containing about 140,000 brick, the new wall to be 24 inches thick up to level of third floor and 18 inches thick from thence to the top of wall.

3. To improve the lighting facilities by enlarging the windows of the building, except those in the west front, first story, and to add two new windows in the south wall of third story.

4. To improve the system of ventilation by arrangements for admitting fresh air and carrying off vitiated air.

5. To construct two fire escapes on the rear of the building.

Operations were rapidly pushed forward and by the close of the fiscal year the work of strengthening the second and third floors had been completed, the east wall had been torn down to the ground, the old worthless foundation torn out and replaced with a bed of concrete 4½ feet wide by 2 feet thick, and the entire wall rebuilt, the lighting facilities improved by enlarging the eight front windows on second and third floors and adding two new windows to the third floor, the method of improved heating and ventilating nearly finished, and the fire escapes constructed in position.

The entire work laid out was nearly completed and the building in such condition as to be available for use by the War Department, if required.

IMPROVEMENT OF THE PUBLIC GROUNDS IN THE DISTRICT OF COLUMBIA.

VARIOUS RESERVATIONS.

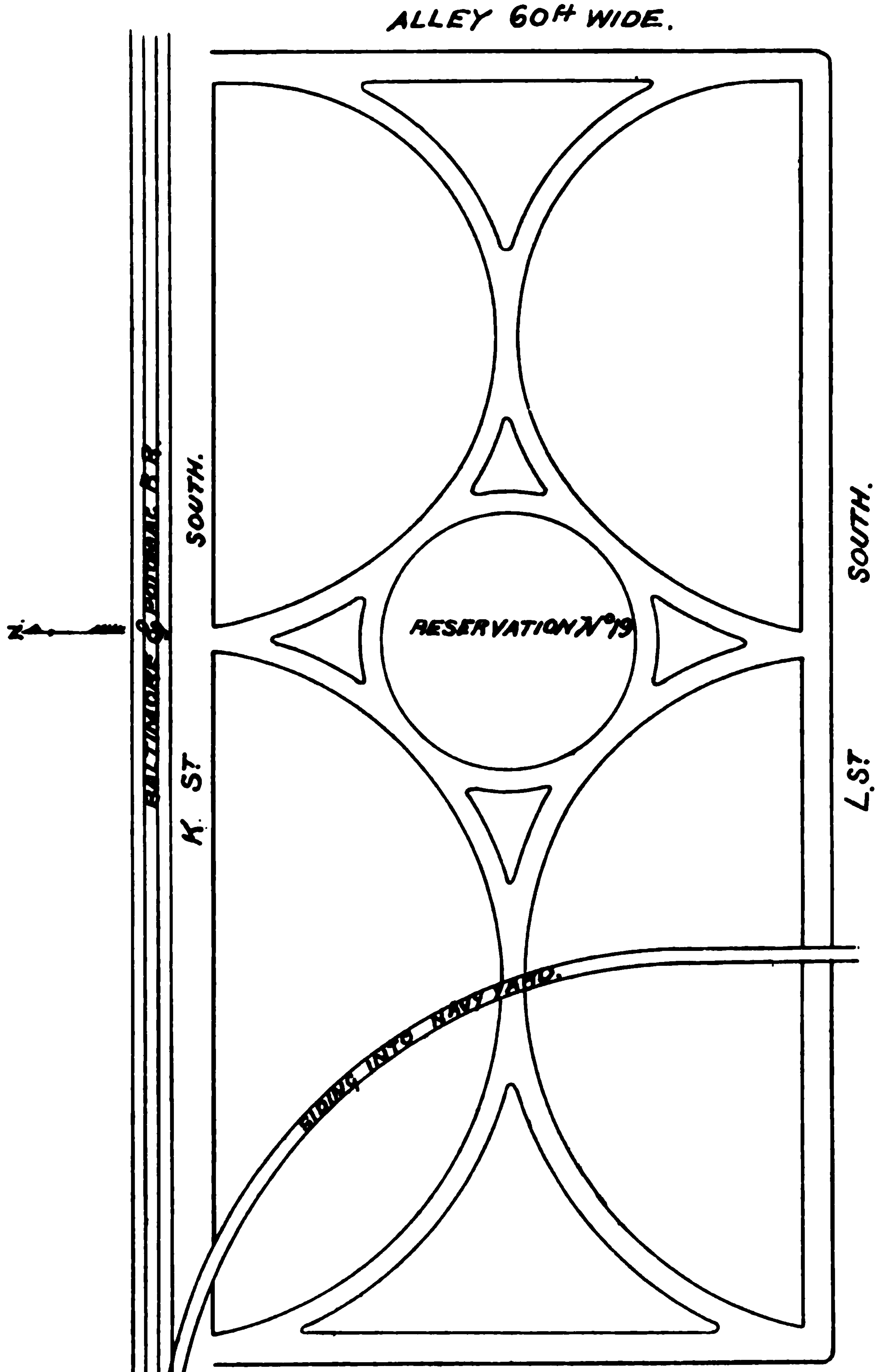
The area covered by the parks and park spaces in the District of Columbia, under charge of this office, is about 405 acres, within which there are 13.4 miles of gravel and asphalt walks, covering an area of 16.9 acres, and 7.6 miles of gravel and asphalt roads, covering an area of 33.03 acres.

There are in all 301 reservations, varying in size from a few hundred square feet to 82 acres. These reservations are classified as follows:

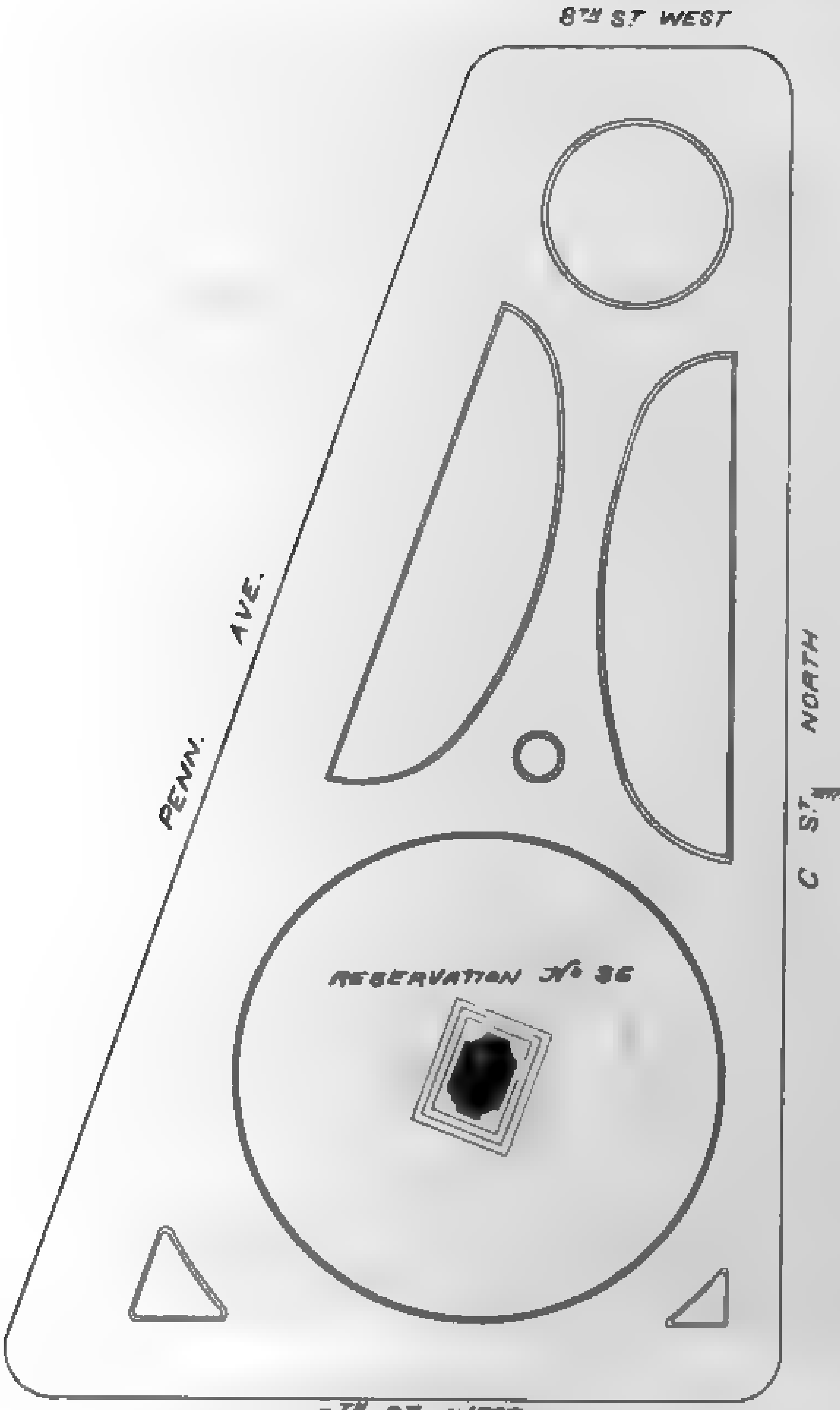
	Number.	Acres.
Highly improved	92	350.38
Partially improved	41	6.01
Unimproved	168	48.69
Total	301	405.08

Of these, 66 are inclosed with post-and-chain or other low iron fences. In my annual report for the last fiscal year I gave a sketch of the general plan proposed for the completion of the park improvements.

Each year an effort is made to add to the list of improved reservations, but owing to lack of necessary funds the progress is very slow. It is not generally realized how much beauty the smaller spaces are capable of exhibiting, should they be brought to their highest condition of improvement. It is, in a measure, true that the outlay in this development is considerable, but the subsequent maintenance of these spots of beauty in their highly improved condition is comparatively

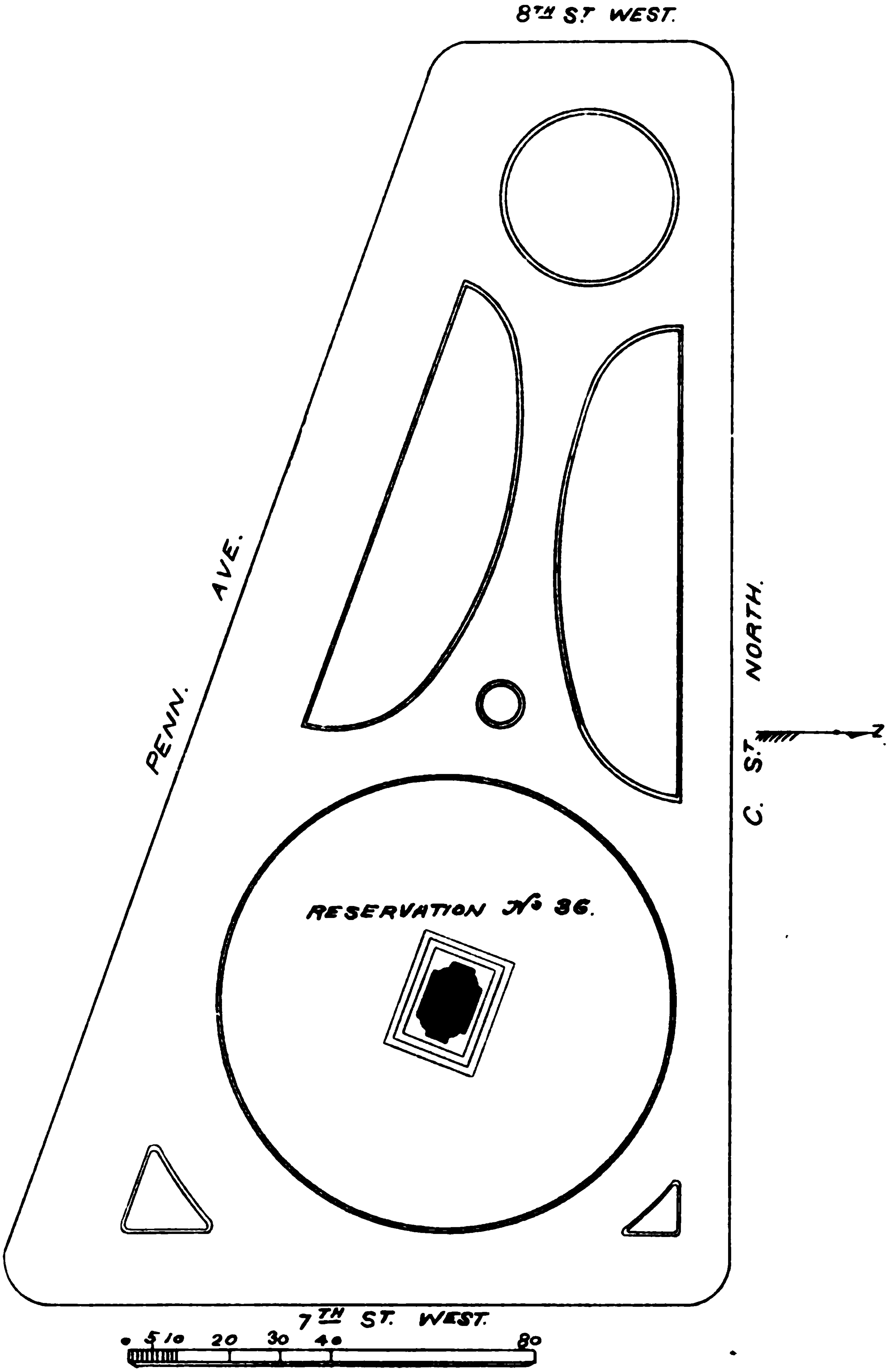


To accompany the annual report upon the Improvement and care of Public Buildings and grounds in the District of Columbia for the fiscal year ending June 30th 1894.

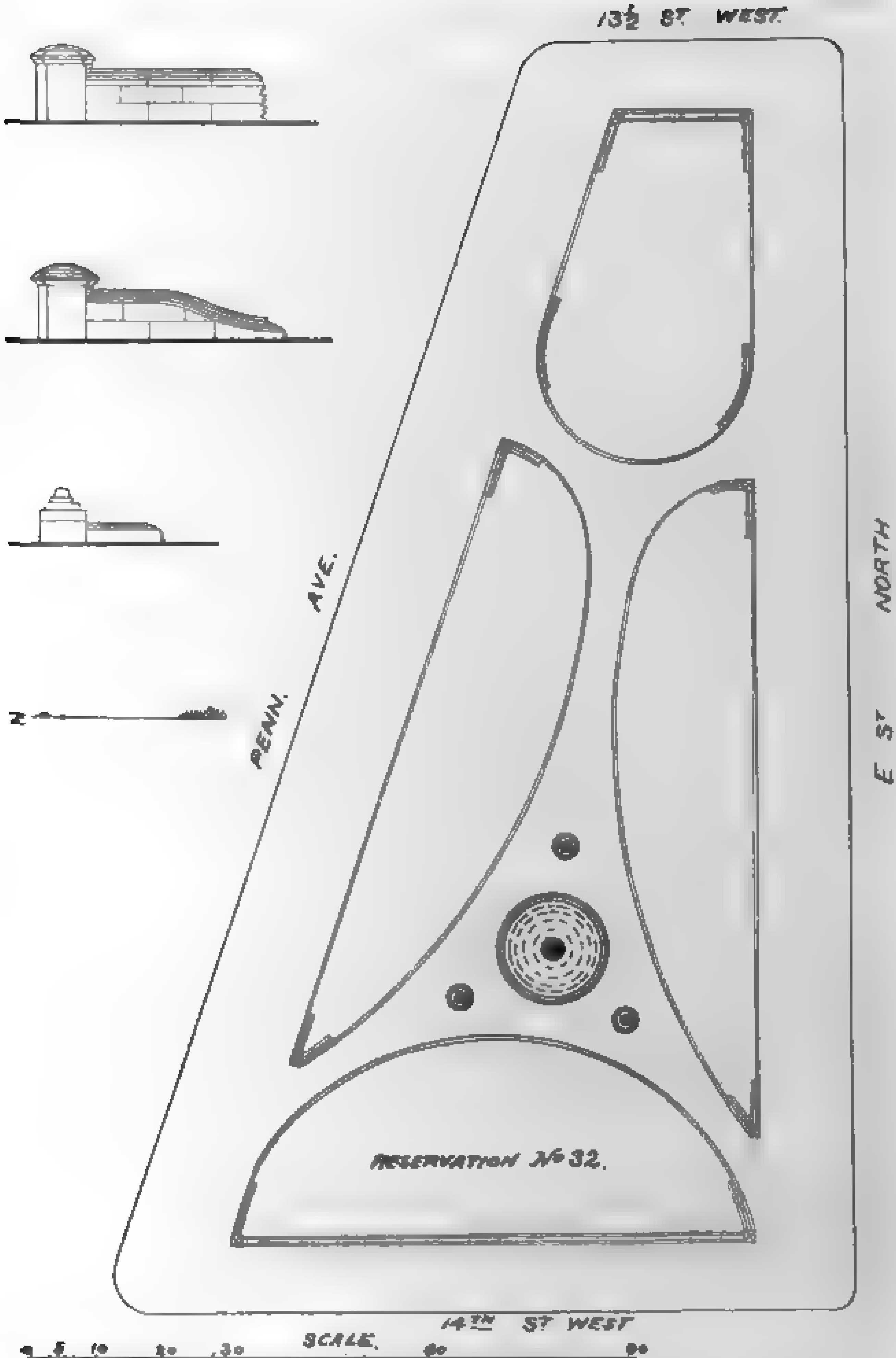


accompany the annual report upon the Improvement and
e of Public Buildings and Grounds in the District of
umbia for the fiscal year ending June 30th 1894.

Eng 53 8



ccompany the annual report upon the Improvement and
e of Public Buildings and grounds in the District of
umbia for the fiscal year ending June 30th 1894.



o accompany the annual report upon the Improvement
nd care of Public Buildings and grounds in the District
f Columbia for the fiscal year ending June 30th 1894.

The park will be lighted by a system of arc electric lamps, as indicated on the plan.

3. Hancock Place (Reservation No. 36, corner Seventh street and Pennsylvania avenue).—This reservation, covering an area of 15,138 square feet, has been selected as the site for the statue of Gen. Hancock, and a plan for its improvement, at an estimated cost of $3,000, is submitted.

It is proposed to construct a circle of 120 feet in diameter, in which a circular mound, 90 feet in diameter, will be formed around the pedestal of the statue, the circle and the mound to be inclosed with a dressed granite curb. There will be raised grass plats and a small circular mound at the west end of the reservation, planted in part with low-growing flowering shrubs, forming a foreground of pretty parklets. The entire pavement within and around the reservation is designed to be of one character, preferably granolithic. It is suggested that the prominent location of this reservation on one of the principal thoroughfares merits the highest type of park improvement, not only to be in keeping with its surroundings, but to prove an attractive ornament to our capital city.

4. Reservation No. 32 (southeast corner of Pennsylvania avenue and Fourteenth street NW.).—This reservation, covering an area of 16,270 square feet, is in one of the most prominent portions of the city, and a plan at an estimated cost of $5,000 is submitted for its improvement.

It is contemplated to remove the old soft maple trees now bordering this small park place which have outlived their usefulness and have lost their ornamental character; to raise the grade in the center about 2½ feet above the present level, and to slope gradually from this point to the margins of the reservation; to construct granite boundary walls and ornamental piers, coping, wing walls, etc., as shown in the plan; to inclose the reservation, except at certain entrances, with an ornamental stone coping; to introduce water pipe; to construct a handsome fountain with basin suitably inclosed with an ornamental stone coping, and to purchase three large iron vases to be placed at walk intersections.

It is also proposed to construct granolithic paths and sidewalks.

The plantings will consist of flowering shrubs and a few trees of medium-sized growth of a decidedly ornamental character.

It is earnestly hoped that funds will be appropriated for this prominent locality.

GROUNDS NORTH AND SOUTH OF THE EXECUTIVE MANSION.

These grounds include those within the iron fences north and south of the White House, together with the entire reservation known as President's Park, south of the White House, Treasury Department, and State, War, and Navy building, north of B street and between Fifteenth and Seventeenth streets.

Within the White House grounds, both north and south, the entire park has been maintained in excellent condition; lawns have been mown, flower beds planted with flowering bulbs and with summer and autumn flowering and foliage plants; trees and shrubs have been pruned, and fountains repaired and planted with water lilies for summer bloom.

It is proposed during the summer of 1894 to replace the uneven worn-down old flag pavement now leading from the Pennsylvania avenue entrances to the north balcony of the Executive Mansion with a granolithic pavement.

It is suggested that the old rubble masonry wall, capped with a worn-down sandstone coping and surmounted by an old iron railing, bounding the grounds of the White House on its north front along the principal avenue of the city, should be removed and give place to a substantial and ornamental structure more in keeping with its prominent location and surroundings. For many years it bore suitable comparison with the sidewalks in front of it and those leading to the mansion, but as the former have been replaced with a granolithic pavement and the latter will be replaced in a similar manner this summer, it is hoped that a handsome wall with an ornamental railing will soon be authorized on the north side of the mansion.

The south grounds of the mansion should be highly improved; the high mounds should be graded and shaped; the gravel walks removed and replaced with artificial stone or granolithic pavements, curbed, and provided with ample drainage so as to be in good condition for travel at all seasons; the northern portion of the grounds outside the iron fence fronting the State, War, and Navy building and the Treasury Department, should be highly improved; the Treasury Department photograph gallery and greenhouses should be removed; bedding plants for use of the Treasury Department could be provided at the propagating gardens if deemed necessary.

The White House stable should be moved from the grounds fronting the State Department, where it is manifestly out of place, and the park generally should receive such further improvement as is needed, by the construction of asphalt walks to replace the gravel walks now in place; additional walks are required for public travel through these grounds, increased water supply for irrigation, and increased drainage facilities.

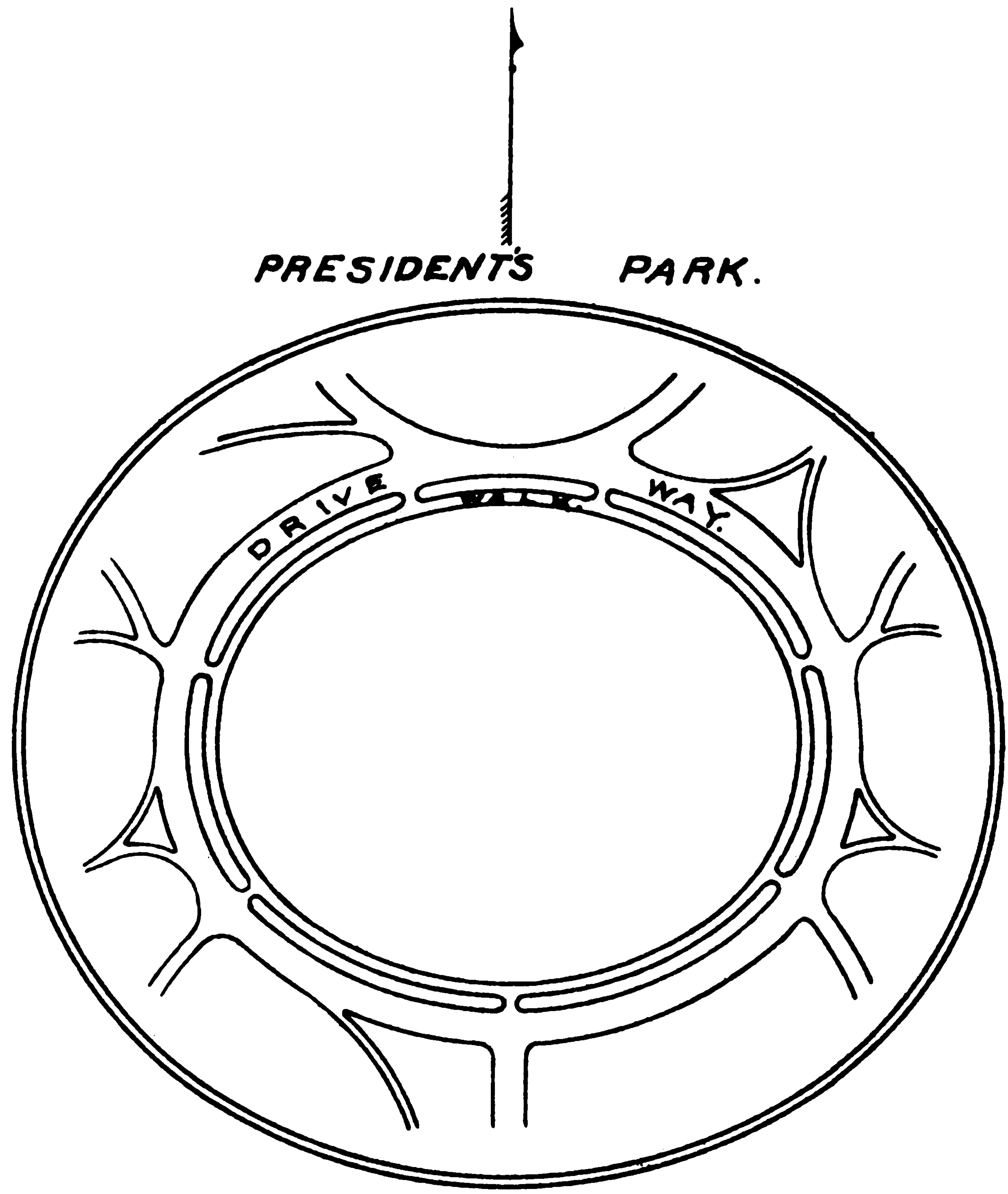
The portion of the grounds south of the iron fence, covering an area of about 82 acres, and heretofore known as the President's Park, have been maintained in very good condition. During the year the main roads have been repaired, raked, and rolled compactly, using for this purpose about 400 cubic yards of gravel; the roads were well watered during the summer season to keep down the dust. All gutters, drain-traps, etc., were kept clean and in good order; 308 linear feet of guttering was relaid, and a new gutter 141 feet long by 2 feet wide was placed where the main roadway leads to Fifteenth street.

The watchman's lodge at the corner of Seventeenth and B streets has been repaired.

The central parade, an even, unbroken lawn surface, extending over an area of 17 acres, is now conceded to be one of the chief attractions of the President's Park. It is oval in form and is surrounded with a smooth, wide, gravel roadway, which has recently become one of the principal drives of the Capital.

It was designed by the celebrated landscape artistic gardener, A. J. Downing, with the view of having on the public grounds an open area of sufficient extent for military evolutions, parades, reviews, etc., and I earnestly hope that it may never be disfigured with structures of any character.

It has been frequently used for drills and parades by our citizen soldiers and by visiting military companies from other cities. Some years since a competitive drill lasting several days took place in the park, and recently the ground was occupied by the Grand Army of the Republic in their memorable reunion. On all of these occasions it has been apparent that a wide walk around the parade would be a desirable feature and afford safe standing room, out of the way of passing



PLAN SHOWING PROPOSED WALK AROUND THE "PARADE."

To accompany the annual report upon the Improvement and care of Public Buildings and grounds in the District of Columbia for the fiscal year ending June 30th 1894.

Eng 53 3

vehicles, for spectators, as well as a path for pedestrians visiting the locality.

With this object in view, it is proposed to construct an asphalt walk, 15 feet wide, around the outer portion of the ellipse, separating it from the carriage road by a parking 30 feet wide.

The American elm trees now bordering the parade would afford partial shade to this walk as well as to the roadway; at all the principal outlets of the park to surrounding streets wide walk openings would be made to connect with these roads, and walk outlets for the convenience of the public.

It is estimated that the approximate cost of this walk, with its approaches, necessary drains, drain lodges, etc., will be $10,500.

Its construction is earnestly recommended.

WASHINGTON MONUMENT GROUNDS.

This park, covering an area of about 78 acres, is the site of the Washington Monument. During the year every effort has been made to maintain the improved portion of the grounds in as good order as possible and to continue improvements so far as the limited funds available would permit.

Lawns have been frequently mown and an abundant supply of hay secured for use of the public animals belonging to the office. The main roads have been repaired, raked, and rolled, gutters and drain traps cleaned and repaired, flower beds laid out, planted, and watered, and a few dead trees removed. The old plank walks have been repaired and 2,836 linear feet of new walks, 4 feet wide, have been laid on lines of pedestrian travel leading to the monument and across the reservation.

Trespass paths have been plowed, sown with rye and grass seed, and protected with stake and wire fences, aggregating 346 feet in length.

At the crossing of Fifteenth street, just east of the propagating gardens, a stone flagging 50 feet in length was laid, backed with cobblestone pavement, and the cobblestone gutter repaired.

By the act of Congress approved August 30, 1890, the officer in charge of public grounds was authorized to set aside a portion of the public grounds for a children's playground, under regulations to be prescribed by him. The southern portion of this park was at once set aside for this purpose, but no regulations were prescribed, as there were no means of carrying them out, no watchmen or policemen having been authorized, and the service of the one watchman on duty at the monument being needed there to protect the structure from acts of vandalism.

Just complaints were received that the lawns were being destroyed, trees injured, and that the children's playground was overrun by vicious and improper persons; this office has been requested to take action to relieve the grounds of such characters and has been obliged to call on the District police for assistance.

To protect the improved grounds as far as possible and to prevent serious annoyance to those enjoying the beauty of the park, the playground was transferred in the autumn of 1893 to the site between B street and the main drive north of the monument; this plot of ground covers an area of about 8 acres and is occupied nearly all the time by men and boys playing football or baseball.

If Congress deems it best to extend the privileges extended by the act of August 30, 1890, then rules and regulations should be prepared assigning certain grounds for young children, other portions for baseball, tennis, football, etc., and there should be regular watchmen on

duty at all hours, not simply for eight hours of the day, whose duty should be to prevent improper characters from interfering with the amusements, and to see that all proper regulations are thoroughly enforced.

It is again earnestly recommended that the electric-light system inaugurated in 1889 in the grounds south of the White House be extended throughout this park; there is now no method of artificial illumination between B street and the propagating gardens south of the monument, between Fourteenth and Seventeenth streets, and in the interest of morality and for the protection of persons necessarily crossing these grounds at night, lights are absolutely necessary; an estimate for electric lights is submitted with this report.

A complete detailed statement of the general plan of improvement projected for this great reservation was submitted in my last annual report.

PROPAGATING GARDENS, INCLUDING THE GREENHOUSES AND NURSERY.

Extensive repairs were made to the various greenhouses during the year, and the large and valuable collection of plants was maintained in good condition; the superstructure of two of the large houses was entirely rebuilt, and that of two others removed, the sidewalls raised, and a new superstructure erected, making a single house of the two old ones.

All furnaces, boilers, flues, and coal-cellars were cleaned, hot water pipes repaired and packed where necessary, and new piers erected, and 400 feet additional of pipe placed in position in one of the houses, hereafter to be used for growing tropical plants. The construction of an additional rose house, 130 feet long, 20 feet wide, and 12 feet 6 inches high, was commenced and pushed well forward toward completion, the work being done by the regular employés when they could be spared from their other duties, and the materials used being mostly old lumber, brick, iron pipe, etc., which had accumulated in past years at the storage grounds. A large amount of shelving was placed in position in the autumn for use in the propagation of plants, and was taken down and stored in the spring, when the plants were placed in the parks.

The main storehouse, which was in rather a dilapidated condition, was underpinned, and the old decayed wooden blocks supporting it were replaced with forty-three brick piers; considerable miscellaneous work was accomplished in constructing and repairing cold frames, wooden shutters for protecting plants, plant tubs, plant boxes, and shades.

About 400,000 bedding plants of about 300 varieties were propagated for spring planting in the public grounds, and particular attention was again given to chrysanthemums for autumn bloom; in the autumn 11,078 plants, consisting of roses, smilax, carnations, heliotrope, geraniums, poinsettas, pansies, candytuft, etc., and 22,250 bulbs, consisting of hyacinths, freesia, lilies, tulips, narcissus, and lilies of the valley, were planted for winter forcing and early spring bloom; about 69,000 bulbs were planted in the public parks for spring bloom.

The nursery grounds were maintained in good condition; roads and walks were raked, repaired and rolled, lawns mown, 411 feet of gutters repaired and drain traps cleaned; all shrubbery was properly trimmed and transplanted where necessary; 25,384 cuttings of flower-

ing shrubs were set out in beds and 1,520 trees and shrubs were lifted and used in the ornamentation of various parks throughout the city.

In the spring about 10,000 plants and 8,000 bulbs were set out and about 60,000 bulbs brought in from the parks, were planted in order to ripen for next season.

The iron fence around the nursery was painted.

In order to protect the greenhouses and storehouses in case of fire, 524 feet of 4-inch pipe was placed in position and connected with the street water main, and 5 fire hydrants were erected.

Extensive improvements can well be made at these gardens; nearly 500,000 plants are annually propagated at the greenhouses for use in the summer and autumn decorations of the public parks; the beautiful water lilies and other aquatic plants used in many of the fountain basins are also propagated here.

The various structures are serviceable for the purposes for which they are used, and have been mainly erected by our own workmen at comparatively cheap cost; they are without ornamentation of any kind, and are maintained in repair by a small annual appropriation of $2,000. The buildings should be increased in number; a large palm house and a subtropical plant house are especially needed; greenhouse pits and cold frames are also required for the purpose of growing hardy herbaceous perennials, no plantings of which of any magnitude have as yet been made in any of the parks or other public gardens in Washington.

The nursery grounds of the gardens, exclusive of the ground occupied by the greenhouses, storehouses, sheds, roads, and walks, cover an area of about 4 acres, one-third of which is occupied by the greenhouse plantings for stock and hardy rose grounds; the remaining portion is thickly planted with young trees and hardy flowering shrubs, set out in rows ready for transplanting when required; this area is not sufficiently large to supply the tree and shrub plantings of the park extensions of the public grounds, and purchases are made of the varieties and character needed from commercial nurseries, and wherever they can be found, to supply deficiencies. It is hoped that in the near future, when the work of filling the Potomac flats near the propagating gardens is completed, the nursery grounds may be extended so as to furnish abundant room for the purposes for which they are intended.

I am frequently in receipt of requests for the loan of plants from the gardens for the use of churches, fairs, festivals, etc., and demands are constantly made for flowering and decorative plants for private purposes.

I have been obliged to decline all such requests, as either the loan or gift of any plants would be in violation of the following extract from the act of Congress approved June 20, 1878:

> *Provided*, That hereafter such trees, shrubs, and plants shall be propagated at the greenhouses and nursery as are suitable for planting in the public reservations, to which purpose only the productions of the greenhouses and nursery shall be applied.

After the annual spring planting in the parks is completed it sometimes happens that there is a small surplus of bedding plants on hand. These are divided among such public reservations or institutions as the State, War, and Navy building, Naval, Providence, Garfield, Columbia, Freedmen's, Homeopathic, and Children's, hospitals, police and fire departments and orphan asylums. After these are supplied, should there still be a few such surplus plants remaining, they are given to whoever may ask for them.

SMITHSONIAN PARK GROUNDS.

This large reservation, located on the "Mall," nearly midway between the White House and the Capitol and between the business sections of North and South Washington, is one of the most popular park resorts of the city. It contains within its boundaries the Smithsonian Institution, the National Museum, and the Army Medical Museum, all of which attract many visitors.

The area of the park is about 58 acres, the greater portion of which is laid out in lawn surfaces, about 9 acres being devoted to roads and walks.

During the year the improvements have been continued and the park maintained in good order. Gravel roads have been repaired, lawns mown, gutters and draintraps cleaned, trees and shrubs pruned. About 277 square yards of asphalt roadway have been laid upon the gravel roadway northeast of the Museum building, and 109 square yards of asphalt foot walks laid upon paths leading toward the Museum. Repairs covering an area in all of about 100 square yards were made to the asphalt roads constructed in former years.

A stake and wire fence, 164 feet long, was erected, running northeast from the northeast corner of the Museum building, to prevent trespassing over the lawn.

In the autumn flower beds were planted with about 1,600 bulbs, which after blooming in the spring were replaced with summer decorative plants.

The lawn surfaces of this park need renovation; they are planted with a great variety of deciduous and evergreen trees, many of them being the most perfect of their kind in the parks in this country.

It is earnestly hoped that the entire appropriation requested for this park may be granted. On account of the constant passage of teams, many of them heavily laden, over the gravel roads it is difficult to maintain them in good condition during the winter and early spring. About eight years since the construction of asphalt pavements was commenced and has continued from year to year, so far as available funds would admit, until now, out of an area of about 45,000 square yards of road and walk surfaces, over 15,000 square yards are of asphalt.

HENRY AND SEATON PARKS.

These two parks have an aggregate area of about 34 acres, mainly laid out in lawn surfaces, the planting of which has not as yet been completed: about 3 acres only are covered by gravel road and walk surfaces. They extend from the Smithsonian grounds to the Botanical Gardens, which in their turn adjoin the United States Capitol grounds, and complete the chain of parks extending from the Executive Mansion to the Capitol.

During the year the main roadway leading from Seventh street across the bridge and on to Third street was repaired, raked, and rolled, about 400 cubic yards of gravel being used for this purpose; all lawns were mown from time to time, roads and walks maintained in neat condition, gutters and draintraps cleaned, a few dead trees removed, lawns repaired where necessary, trees and shrubs pruned, and flower beds planted; the improvement of the large mound, constructed some years since to screen the Baltimore and Potomac depot from the park, was continued; 200 linear feet were graded, covered with soil, sown with

grass seed, planted with deciduous evergreen trees, and protected at each end from trespassers by stake and wire fences.

The violent storms on the nights of August 28, 1893, and February 25, 1894, did considerable damage to the trees, shrubs, and flower beds in Smithsonian, Henry, and Seaton parks, necessitating the removal of 27 cart loads of broken limbs, brush, etc., after the storm of August 28.

RESERVATIONS NORTH OF PENNSYLVANIA AVENUE AND WEST OF CAPITOL.

This division of the city embraces all the public reservations located between First and Twenty-eighth streets west and B street and Florida avenue north, the majority of which are in an advanced condition of improvement, and require the constant attention of a force of skilled laborers employed for their proper maintenance.

It includes the highly improved parks known as Washington Circle, Rawlins Square, Du Pont Circle, Scott Circle, Lafayette Square, Franklin Square, Farragut Square, McPherson Square, Mount Vernon Square, Iowa Circle, Thomas Circle, Judiciary Square, and a number of other smaller but highly improved reservations. During the year lawns have been properly mown, seeded down, or sodded where winterkilled, watered during the dry season, and their margins edged and trimmed; the gutters and drain lodges have been cleaned; trees and shrubs have been pruned and cultivated, and the young trees and shrubs and flower beds watered during dry season; new trees and shrubs were planted, and beds of ornamental foliage, flowering and tropical plants set out; snow and ice removed from paths through and around the parks during the winter. This is a part of the regular annual work necessarily mentioned in the reports.

The asphalt walks in Lafayette, Franklin, and Farragut squares were repaired and resurfaced over an area of 463 square yards; in Judiciary Square 48 square yards of new asphalt roadway and 169 square yards of new walks were laid; all the gravel roads and paths in all reservations were repaired and maintained in good order. All vases were filled with handsome plants, and water lilies were planted, and goldfish placed in fountain basins.

In Lafayette Square the drainage system was improved, a new gravel path was constructed east of the lodge, and a group of evergreens planted on the foundation originally intended for the Lafayette statue; this group consisted of 94 evergreen trees and 175 yucca plants; 5 old and unsightly trees were removed from the park.

In Franklin Square 8 unsightly trees were removed, a privet hedge planted on the east and west sides of the lodge, and 153 feet of bluestone flagging, 4 feet wide, laid from the main path to the doors of the lodge.

In Judiciary Square portions of the main gravel roads were resurfaced with about 300 cubic yards of gravel, a granite block apron was laid at the entrance at Fourth and E streets, 377 shrubs and 100 yuccas were planted, and 7 unsightly trees and shrubs were removed.

In Du Pont Circle the asphalt paths were repaired with Portland cement, the pedestal of the Du Pont statue pointed with cement, and the steps leading thereto reset.

Reservation No. 29, on north side of Pennsylvania avenue, between Twentieth and Twenty-first streets, was properly graded, seeded, and sodded where necessary, a flower bed laid out and planted, trees and shrubs planted, the reservation inclosed with a post and chain fence, and the brick sidewalks repaired. The walks were repaired and new

gutters constructed in Reservation No. 28, on the south side of Pennsylvania avenue, between Twentieth and Twenty-first streets.

In Washington Circle the gravel walks were repaired, the drainage improved, a new gutter, 41 feet long, constructed, and 171 shrubs set out.

In the autumn of 1893, 34 flower beds were prepared and planted in the various parks with spring-flowering bulbs; 41,745 bulbs, consisting of hyacinths, tulips, crocuses, etc., were used for this purpose; 15 flower beds were filled with chrysanthemums, which bloomed during the late autumn. In the spring of 1894, 110 flower beds were filled with flowering and foliage plants for summer decoration.

A number of shrubs were set out and a flower bed prepared and planted in the grounds attached to the Department of Justice.

In Scott Circle and adjacent reservations three dwarf trees which had become unsightly were removed, and the statue of Gen. Scott, which was found to be slightly out of position, was properly placed and secured to the pedestal with bronze bolts.

The violent storms of August 28, 1893, and February 25, 1894, did considerable damage to the trees and shrubs in this section and necessitated the removal of several large and valuable trees that had been so badly injured as to render them useless.

Much work is still required in this beautiful section of the city; the parks should all be surrounded by granite curbings; all walks and roads should be of asphalt; the roads should have curbings and be properly drained; this is particularly true of Judiciary Park, which covers an area of about 20 acres, and the gravel roads of which are almost as much traveled as those of the adjacent streets and equally subject to wear from heavily loaded teams, rendering it very difficult to maintain them in good condition for travel during the winter. The first cost of asphalt roads and granite curbings would of course be approximately large, but the subsequent saving in the cost of their maintenance would in the course of a few years more than compensate for the original outlay.

In all the parks the lawn, tree, and shrub plantings should be well cared for and maintained in the highest degree of excellence. This will necessitate from time to time not only considerable trimming but the removal of occasional trees and shrubs where too thickly planted, to secure future benefits not apparent to the casual observer.

RESERVATIONS EAST AND SOUTH OF CAPITOL.

This division of the city includes within its limits the highly improved reservations known as Lincoln, Garfield, Folger, Stanton, and Marion parks.

In all of these reservations as well as in a number of smaller improved parks, the lawns were mown and seeded or sodded where winterkilled; all roads and paths were raked, repaired, and rolled, trees and shrubs pruned and watered, flower beds planted, and during the winter snow and ice removed from paths.

In Garfield Park the improvement of the drainage system was continued by laying 1,526 linear feet of cobblestone gutters and placing 63 feet of 4-inch drain pipe in trenches opened for that purpose.

In Stanton Park the drainage from the fountains which had become clogged was improved by laying 84 feet of 6-inch terra cotta pipe.

The fountains were repaired, put in good order in Lincoln, Stanton,

and Folger parks, and water lilies placed in the fountain basins in Stanton and Folger squares.

Repairs were made to the lodge in Lincoln Park, including the plumbing.

In the autumn of 1893, 10 flower beds were planted with 22,182 spring-flowering bulbs, consisting of hyacinths, tulips, crocuses, and scillas, and in the late spring of 1894, 44 flower beds were filled with flowering and foliage plants; the large vase in Marion Square was filled with tropical and flowering plants.

Minor improvements were made to a number of smaller reservations throughout this section of the city.

The final improvements projected for Garfield Park, covering an area of about 24 acres, are nearing completion. The main gravel road through this park leading to Virginia avenue is used as a thoroughfare for heavy teams which renders it difficult to maintain it in good condition during the winter season.

It is regretted that the reduced appropriations will prevent the continuance of any extensive improvements, the amount available being not more than sufficient to maintain in good order the roads, walks, gutters, drains, lawn surfaces, trees, shrubs, and other improvements.

Stanton, Folger, and Marion parks are highly improved, planted with choice specimens of trees and shrubs and laid out with gravel paths. There are fountains in Stanton and Folger parks, and Stanton Park contains the bronze equestrian statue of Gen. Greene. The gravel walks in these reservations should be covered with asphalt.

In addition to these parks there are 28 small public spaces which have been partly improved and planted and about 100 similar spaces at the intersections of streets and avenues yet unimproved.

The increased prosperity of this section of our city and the large number of private improvements in progress demand that still more attention be given to beautifying the public spaces, and increased appropriations are earnestly recommended for this purpose.

SETTEES, TOOLS, MANURE, CONSTRUCTION AND REPAIR OF POST AND CHAIN FENCES, AND REMOVING SNOW AND ICE.

Repairs were made to the park settees so far as funds would admit; 515 settees were repaired and about 600 painted. A large number of settees now on hand require immediate repair and the appropriation for 1895 will be used for this purpose.

Repairs were made to lawn-mowers, wheelbarrows, and miscellaneous tools; edge tools were sharpened and put in good order, and new tools purchased from time to time when necessary.

About 900 cubic yards of manure, 800 cubic yards of soil, and 163 cubic yards of potting sod were purchased.

About 2,000 cubic yards of compost were prepared and used in top dressing the lawns of various parks, in mulching trees and shrubs, and enriching flower beds; potting compost was also made for use in growing plants in the greenhouses.

An iron post-and-chain fence was placed around Reservation No. 29, on Pennsylvania avenue between Twentieth and Twenty-first streets, and repairs were made to a number of post-and-chain fences where necessary.

A large number of iron post caps which had been broken or stolen by mischievous boys were replaced with new caps.

The snow and ice were promptly removed from the paths and sidewalks through and around various reservations.

Fortunately the winter of 1893-'94 was not severe and the entire appropriation was not expended. Usually the amount appropriated is not sufficient, and during the winter of 1892-'93 the funds available for this work were exhausted by February 18.

The length and area of the sidewalks through and around the various reservations cover a total distance of 30 miles and an area of 42 acres. It is earnestly urged that the sum of $1,500 may be appropriated for the next fiscal year. Should the winter be so mild that the whole sum will not be needed, any remaining balance will be turned into the Treasury.

THE SPRING SUPPLYING THE CAPITOL WITH DRINKING WATER.

This spring, located within the limits of the new reservoir near the Soldiers' Home, and which supplies the Capitol building, is pronounced by skilled experts, after careful analysis, to furnish by far the purest water we have in this city.

It was purchased by the United States from Mr. John A. Smith, November 26, 1833, for the sum of $3,150, and at a later date by deed of October 20, 1836, the United States, for the sum of $5,000, acquired title to an acre of ground around the spring, together with the water flowing, or to flow, through part of Mr. Smith's farm by two covered drains.

By deeds dated September 29, 1833, January 29, 1834, and February 22, 1834, for the total sum of $1,450, the United States obtained the right of way for a pipe line through certain private property, from Messrs. James, David, and James Moore, jr., George Beall, and Elizabeth Dunlop.

It is believed that the pipe has been tapped during past years by unauthorized parties, and careful and accurate observations were taken from time to time during the present year to determine the inflow at the spring and the discharge at the Capitol. The result shows that while the inflow averages 526 gallons per hour, the discharge at the Capitol averages only 480 gallons per hour, showing a clear loss of 46 gallons per hour between the spring and the Capitol. This possibly may arise from leakage of pipes along the line, but it is highly probable that the pipe has been tapped, for there are occasions when, with a full head of water entering at the spring, for short periods, there is no discharge at the Capitol.

The line of pipe extends from the spring house along the bottom of a former ravine to a stopcock near Florida avenue (formerly Boundary street), a distance of about 5,000 feet; from thence it runs down Florida avenue to North Capitol street and thence to the Capitol, a distance of about 8,600 feet, making a total length of 13,600 feet of pipe; 6-inch heavy-pressure pipe for the remainder, the greater portion of which was laid over fifty years ago; the fall between the spring house and the Capitol is 35 feet.

From time to time during the past twenty years, when leaks have been discovered and the pipe laid bare for repairs, it has been found to be in excellent condition and but slightly corroded inside. This was found to be the case when work upon the embankment of the new reservoir was commenced. The section of the pipe which is now under the embankment was uncovered for the purpose of replacing it with new materials, but it was found to be quite as good as new and was simply encased in cement concrete.

The excellent condition of this pipe is, doubtless, to a great extent due to the purity of the spring water.

From the spring house the pipe was originally laid along the bottom of a ravine which formerly extended to Florida avenue, but which now exists only in part, having been completely filled in the section near the avenue. New streets have been laid out and houses erected between S street extended and Florida avenue, and in some places the pipe is now over 20 feet under ground.

Some of the owners of the land appear to have known that the United States had a certain right of way in the vicinity, but being uncertain as to its exact location, have made provision in deeds transferring property that the sale was subject to the right of way granted the United States, if said right of way passed through the lot transferred.

If this spring-water supply to the Capitol is regarded to be of sufficient value to be continued, it is very evident that some action must be taken at an early day to divert the pipe line from the part of the ravine not yet filled to the nearest new street running north and south to Florida avenue, otherwise it is a mere question of time when at some deep point in the heavy filling a serious leak may occur which will find an outlet in some adjacent sewer and the supply at the Capitol will cease. Such a leak could not easily be discovered, and if discovered could not be easily repaired.

It has been found that the pipe at V street extended is only 12 feet below grade, and it is recommended that the line be diverted at the manhole on V street through that street to First street, thence down First street to Florida avenue, thence along Florida avenue to North Capitol street; it is further recommended that the section of the pipe from V street to the new reservoir be encased in Portland cement concrete, as was done to the portion under the reservoir embankment. In the near future this section will be buried out of reach when the portion of the ravine is filled to the grade of adjacent streets; houses will be erected over it and it will be almost impossible to reach it. If encased in concrete, it will practically last for an indefinite period, for should the iron fail, the artificial stone coating would be a permanent channel to V street; the length thus to be encased would be about 1,200 feet.

The length of the new pipe required along V street, First street, and Florida avenue would be about 3,500 feet.

It is further recommended that the entire line along North Capitol street shall be uncovered, so that the pipe may be carefully inspected, repairs made if necessary, the section under the tracks of the Baltimore and Ohio Railroad encased in Portland cement concrete, and any unauthorized pipes along the route disconnected.

The cost of the work suggested is estimated at $10,000.

In the future there will be another serious problem to solve in preserving this spring-water supply to the Capitol should the new reservoir be used as a settling reservoir. The spring house will have to be encased with a water-tight wall to extend above the water line of the reservoir, and measures must be taken to prevent the Potomac water from mingling with that of the springs; it is believed that this can be accomplished.

WATER PIPES AND FIRE PLUGS AND CARE AND REPAIR OF FOUNTAINS IN THE PARKS AND RESERVATIONS.

Repairs have been made to the water pipes and valves from time to time, when necessary. In the autumn water was shut off from the various parks, and the hose valves removed and stored at the nursery grounds; in the spring these valves were replaced in the parks.

At the propagating gardens, for the protection of the valuable greenhouses from fire, 524 feet of 4-inch pressure pipe was laid and connected with the street main, and five fire hydrants were placed in position.

In the grounds south of the Executive Mansion, the water pipe was extended 412 feet to the storage grounds at corner of Seventeenth and B streets, in order to be available at the compost grounds.

There are 22 fountains with basins in charge of this office, located as follows: Executive Mansion grounds, 3; Lincoln Square, 2; Stanton Square, 2; Rawlins Square, 2; and 1 each in Folger Square, Judiciary Square, Mount Vernon Square, Franklin Square, Iowa Circle, and the reservations at Massachusetts avenue and Twentieth street, New York avenue and Third street, Pennsylvania avenue and Ninth street, Pennsylvania avenue and Thirteenth street, Pennsylvania avenue and Nineteenth street, Pennsylvania avenue and Twenty-first street, Pennsylvania avenue and Twenty-eighth street, and Delaware avenue and First street E.

With a few exceptions the jets are of a very simple character.

There are 24 drinking fountains in the various parks; these were repaired where necessary, properly painted, and cups and chains renewed. The fountain basins were properly cleaned and thoroughly repaired before water was turned on in the spring; the large fountains in Mount Vernon Square, at the corner of Pennsylvania avenue and Ninth street, and at the corner of Pennsylvania avenue and Twenty-eighth street were scraped and painted.

In the autumn the water was turned off in the fountains, the jets removed and stored at the nursery shops; these jets were repaired where necessary during the winter and replaced upon the fountains in the spring.

PAINTING WATCHMEN'S LODGES, IRON FENCES, VASES, LAMPS, AND LAMP-POSTS.

There are 9 watchmen's lodges, 406 lamps, 18 vases, a large number of post-and-chain fences, the high iron fences around the Executive Mansion, and the iron fence around the greenhouses and nurseries under charge of this office.

For painting all of these the sum of $500 was appropriated for the present fiscal year; the result was that much necessary work was omitted.

It is earnestly recommended that the sum of $1,500 be appropriated for this work during the next fiscal year. During the past year the following have been painted: The watchmen's lodges at Washington Circle, Lafayette Square, Franklin Square, Seaton Park, Smithsonian Park, and Lincoln Park; the post-and-chain fences at Judiciary Park, Smithsonian Park, and 13 smaller reservations, covering in all 1,098 posts with the necessary chain; the iron railing around the Lincoln statue near City Hall; the lamps and posts upon the balconies and in the grounds of the Executive Mansion; 122 lamps and posts and 20 drinking fountains in various reservations.

The remainder of the lodges, lamp-posts, vases, post-and-chain and high iron fences will be painted during the fiscal year 1894–'95 if funds are available. This painting becomes necessary annually, in order to assist in maintaining the beauty and neatness of the parks.

LIGHTING THE PUBLIC GROUNDS.

The usual attention has been paid to the gas lamps in the various parks during the year, and the lanterns maintained in as good repair as possible.

The grounds immediately south of the Executive Mansion are illuminated by arc electric lights.

There are 406 ordinary gas lamps with 455 burners and 2 arc gas lamps belonging to this department. Of this number during the year 52 burners in lanters on the sidewalks, outside the reservations, have been lighted at the expense of the District government. The number of lamps not connected with meters, lighted during the year and paid for by this department, was as follows:

	Single burners.
July 1, 1893, to June 19, 1894	261
June 20, 1894, to June 30, 1894	301

Each of these lamps burned about 3,000 hours and consumed about 18,000 cubic feet of gas. In addition to these there are 71 burners within the Executive Mansion grounds connected with the meters of the mansion.

It is earnestly recommended that the system of electric lights now in operation upon many of the streets and avenues of the city of Washington be gradually extended to the public grounds. With the gas lamps now in use in the parks the illumination is far from satisfactory, and in the interest of morality, as well as the welfare of those visiting and passing through the parks after dark, it is desired to make them as brilliant as possible at night.

Estimates are submitted with this report for arc electric lights in Lafayette, Franklin, and the Monument parks. In the future the system can be extended to the Smithsonian and the other parks on the "Mall."

TELEGRAPH CONNECTING THE CAPITOL WITH THE DEPARTMENTS AND GOVERNMENT PRINTING OFFICE.

The telegraph lines now under control of this office are as follows:

The line of overhead wires consists of 78 poles, covering a distance of about 3½ miles, with a length of about 8 miles of wire. This line, starting from the State, War, and Navy Building, runs to the Executive Mansion, thence to the Treasury Department, thence to G street, thence to Eighth street, thence to H street, thence to North Capitol street, and thence to the Capitol. Connected with it is one running from the Treasury Department along Fourteenth street to the Bureau of Engraving and Printing, and one down Fifth street to the Pension Building.

There is about 500 feet of 13-conductor Patterson cable running from the cable pole in the Capitol grounds into the basement of the Senate, and 250 feet of 20-conductor cable running from the cable pole on the corner of Seventeenth and G streets into the State, War, and Navy Building.

The underground cable laid by the Standard Underground Cable Company of Pittsburg, in October, 1883, under permit granted for experimental purposes, and afterwards purchased by the Government in accordance with an act of Congress, has been useless for telegraphic operations since the winter of 1891-'92, owing to the manner in which it was laid, being without any protection from the picks, etc., of workmen in the streets. The cable was laid about 12 or 15 inches below the surface of the ground in a wooden box filled with sand. After two or three years the boxing decayed and was no longer a protection. When a workman began to dig up the streets and stuck a pick into the cable it was quickly covered up without giving notice of the damage done, and soon the dampness would show the defect. As there were

no manholes for testing, it was impossible to discover the fault without digging up the streets at considerable expense. The underground line was therefore abandoned.

During the past year the main battery in this office and the local batteries and instruments in the various Departments have been maintained in good condition. Obstructions of all kinds were removed from the overhead lines as soon as possible and all breaks repaired. The entire line was carefully examined, 3 decayed poles replaced with new ones, new cross-arms put up, and slack wire cut out.

About 4 miles of old wire was removed and replaced with new No. 12 galvanized-iron wire and No. 12 copper conductor weatherproof wire. This weatherproof wire was run through trees along the line, and was most useful during the past winter.

The telegraph office of the U. S. Senate was moved from the Secretary's office to the Senate reception room, and the telegraph office of the House of Representatives was moved from the main corridor to the lobby.

The Marine Hospital branch of the Treasury Department, located on the corner of New Jersey avenue and B street SE., was connected with the line during the year.

Attention is again respectfully invited to the fact that it is becoming more and more difficult to operate the overhead telegraph system owing to the growth of trees along the line which interrupt the electric currents, especially during wet and windy weather.

The necessity for either replacing the present poles with taller ones or constructing a system of underground cable is so apparent as scarcely to need argument in its favor. I submit two estimates, the one for the underground cable, amounting to $25,000, the other for high poles, amounting to $1,600.

Should the high overhead plan be adopted by Congress, authority should appear in the law making the appropriation to continue the line on the south side of G street, between Ninth and Eleventh streets NW. At present the line crosses to the north side of the street at Eleventh and G and continues on that side for two squares. As the lines of the Western Union are on the north side, it will be difficult, if not impossible, to raise our lines above the trees without crossing to the south side.

In the construction of the underground system, which will cover a distance of about 17,000 feet, it is proposed to use two of the best quality of six-wire telegraph cables, placed in first class iron pipe, dressed and made bright inside, and then enameled to prevent corrosion and injury to cables, with 3 brick manholes to every 1,000 feet, so arranged that the cables can be withdrawn for repairs when necessary.

The cost of such a system with its various connections complete would be $25,000.

The time for obstructing the streets with telegraph poles and a network of wires has passed, and it is earnestly urged that the necessary appropriation for the underground system of telegraph, connecting the Capitol with the various Departments and the Government Printing Office shall be made available as soon as practicable.

SURVEYING AND DRAFTING.

The time of the only draftsman allowed this office is mainly taken up with the care of the old records of the city of Washington. He is required to be in his office the greater portion of each day to exhibit

these records to those interested, and is frequently summoned to produce them in court.

During the year he has completed, under my direction, a map showing every United States reservation in the city of Washington, with a description of each one; he has surveyed several small reservations, has made soundings on the line of the dock now being constructed at Wakefield, Va., and has prepared under my direction detailed drawings for the dock.

As heretofore stated, Mr. John Stewart, the draftsman, who has had the immediate charge of the old records of the city for nearly a score of years, informs me that in his investigations he can find no satisfactory evidence to show that the United States has ever received payment or granted deeds in fee for twenty entire squares and about 2,000 lots in different parts of the city of Washington.

I again invite attention to this important matter and urgently recommend that provision be made for the employment of a clerk to take charge of these old records, and to make a complete and exhaustive investigation of this whole subject, and thus permit the only draftsman allowed this office to attend to his legitimate duties.

RESERVATIONS OCCUPIED, IT IS BELIEVED, IN VIOLATION OF LAW.

The following reservations claimed as the property of the United States are now occupied, it is believed, without authority of law:

Reservations Nos. 113, 127, and 197, by the Baltimore and Potomac Railroad Company.

Reservation No. 226, by the Baltimore and Ohio Railroad Company.

Reservation No. 125, by the Central Union Mission as a place of worship.

Reservation No. 186, by the Bethany Chapel of the New York avenue Presbyterian congregation.

Reservation No. 293, intersection of Canal and N street south and First street west; occupied by a party who built a frame house thereon in 1888; this case has been in the hands of the United States District Attorney for the District of Columbia for the past six years.

Reservation No. 249 is occupied as a lumber yard by a party who claims to rent it from a gentleman in Port Deposit, Md.

Reservations No. 137, 138, 141, 152, 164, and 169 have been inclosed with iron or wire fences and partially improved by the owners of adjacent property.

STATUES.

There are 14 statues in the public grounds under charge of this office, as follows: Washington, Greene, Jackson, Lincoln (2), Scott, Farragut, Thomas, Du Pont, Rawlins, McPherson, Garfield, Henry, and Lafayette; all of these are in good condition, but there should be a small annual appropriation for pointing up the pedestals and cleaning the statues.

It is anticipated that within the next two years statues will be erected to the memory of Gens. Sheridan, Hancock, and Logan.

Estimates for the fiscal year ending June 30, 1896.

Salaries of employés, public buildings and grounds, etc.:	
One office clerk	$1,600.00
One messenger	840.00
One public gardener	2,000.00

Salaries of employés, public buildings and grounds, etc.—Continued.		
One clerk in charge of old public records of Washington city	$1,500.00	
One clerk	1,400.00	
One electrician and telegraph lineman	1,080.00	
Overseers, draftsmen, foremen, gardeners, mechanics, and laborers	35,000.00	
One captain of the watch	1,200.00	
One day watchman in Lafayette Square	660.00	
One day watchman in Franklin Square	660.00	
Two day watchmen in Smithsonian grounds, at $660 each.	1,320.00	
Two night watchmen in Smithsonian grounds, at $720 each	1,440.00	
One day watchman in Judiciary Square	660.00	
One night watchman in Judiciary Square	720.00	
One day watchman at Lincoln Square and adjacent reservations	660.00	
One day watchman at Iowa Circle	660.00	
One day watchman at Thomas Circle and neighboring reservations	660.00	
One day watchman at Washington Circle and neighboring reservations	660.00	
One day watchman at Dupont Circle and neighboring reservations	660.00	
One day watchman at McPherson and Farragut squares.	660.00	
One day watchman at Stanton Square and neighboring reservations	660.00	
Two day watchmen at Henry (Armory) and Seaton squares, at $660 each	1,320.00	
One night watchman at Henry (Armory) and Seaton squares	720.00	
One day watchman at Mount Vernon Square and adjacent reservations	660.00	
One day watchman at grounds south of the Executive Mansion	660.00	
One watchman for greenhouses and nursery	660.00	
One day watchman for Marion Square, Folger Square, and adjacent reservations	660.00	
One day watchman at Garfield Park	660.00	
One night watchman at Garfield Park	720.00	
One day watchman at Rawlins Square and adjacent reservations	660.00	
		$61,420.00
Contingent expenses, public buildings and grounds		500.00
Improvement and care of public grounds:		
Improvement and maintenance of grounds north and south of Executive Mansion	5,000.00	
Ordinary care of greenhouses and nursery	2,000.00	
Ordinary care of Lafayette Square	1,000.00	
Ordinary care of Franklin Square	1,000.00	
Ordinary care of Lincoln Square	1,000.00	
Care and improvement of Monument grounds	10,000.00	
Continuing improvement of Reservation No. 17 and site of old canal northwest of same	5,000.00	
Construction and repair of post-and-chain fences, repair of high iron fences, and constructing stone coping about reservations	1,500.00	
Manure, and hauling same	5,000.00	
Painting watchmen's lodges, iron fences, vases, lamps, and lamp posts	1,500.00	
Purchase and repair of seats	1,000.00	
Purchase and repair of tools	2,000.00	
Trees, tree and plant stakes, labels, lime, whitewashing, and stock for nursery	3,000.00	
Removing snow and ice	1,500.00	
Flower pots, twine, baskets, wire, splints, moss, and lycopodium	1,000.00	
Care, construction, and repair of fountains	1,500.00	
Abating nuisances	500.00	

Improvement and care of public grounds—Continued.		
Improvement, care, and maintenance of various reservations	$20,000.00	
Improvement, maintenance, and care of Smithsonian grounds, etc	8,000.00	
Improvement, care, and maintenance of Judiciary Square	7,000.00	
Granite curbing about Franklin Square	5,000.00	
Laying asphalt walks in various reservations	5,000.00	
Improvement and care of Henry and Seaton parks	5,000.00	
Construction of a large greenhouse at the propagating gardens, for palms and tropical plants of large growth, needed for tropical bedding, etc., in the public parks during the summer months	6,000.00	
Improvement of Howard University Park	25,000.00	
For lodges for park watchmen at Stanton, Mount Vernon, Iowa, Dupont, Thomas, McPherson, and Folger reservations, at $500 each	3,500.00	
Cleaning statues and repairing pedestals	200.00	
Improvement of Reservation No. 32, southeast corner Pennsylvania avenue and Fourteenth street NW	5,000.00	
Improvement of Hancock Place, corner Pennsylvania avenue and Seventh street NW	3,000.00	
Improvement of Reservation No. 19, near navy-yard	12,000.00	
Construction of an asphalt walk 15 feet wide on the outer border of the ellipse in the grounds south of the Executive Mansion	10,500.00	
For expenses, including advertising, of sale of old condemned and useless property	100.00	
		$158,800.00
Care, repairs, fuel, etc., Executive Mansion:		
For care, repair, and refurnishing Executive Mansion, to be expended by contract or otherwise, as the President may determine	25,000.00	
Fuel for Executive Mansion, greenhouses, and stable	3,000.00	
Care and necessary repair of greenhouses	5,000.00	
New superstructure of iron and glass for the conservatory	13,000.00	
		46,000.00
Lighting the Executive Mansion and the public grounds:		
Gas; pay of lamplighters, gasfitters, and laborers; purchase, erection, and repair of lamps and lamp posts; purchase of matches, and repairs of all kinds; fuel and lights for office and office stable, for watchmen's lodges, and for greenhouses at the nursery: *Provided*, That for each 6-foot burner not connected with a meter in the lamps on the public grounds no more than $21.50 shall be paid per lamp for gas, including lighting, cleaning, and keeping the lamps in repair, under any expenditure provided for in this act; and said lamps shall burn not less than 3,000 hours per annum; and authority is hereby given to substitute other illuminating material for the same or less price, and to use so much of the sum hereby appropriated as may be necessary for that purpose	15,000.00	
Electric lights for 365 nights, from 7 posts, at 40 cents per light per night, $2.80 per night	1,022.00	
Lighting the Monument grounds with electric lights:		
For 6,642 feet 5-inch terra-cotta pipe laid complete with manholes, at 60 cents per foot	3,985.20	
For 18 iron poles, complete in position, at $19.50 per pole	351.00	
Lighting Lafayette Park with electric lights:		
For 1,305 feet 5-inch terra-cotta pipe laid complete, with manholes, at 60 cents per foot	783.00	
For 6 iron poles complete in position, at $19.50 per pole	117.00	
Lighting Franklin Park with electric lights:		
For 1,442 feet 5-inch terra cotta pipe laid complete, with manholes, at 60 cents per foot	865.20	

Lighting the Executive Mansion and the public grounds—Continued.		
Lighting Franklin Park with electric lights—Continued.		
For 9 iron poles complete in position, at $19.50 per pole	$175.50	
For lighting for 365 nights 33 arc electric lights in the Monument grounds, Lafayette and Franklin parks, at 50 cents per light per night	6,022.50	
		$28,321.40
Repairs to water pipes and fire plugs:		
Repairing and extending water pipes, purchase of apparatus for cleaning them, purchase of hose, and for cleaning the springs and repairing and renewing the pipes of the same that supply the Capitol, the Executive Mansion, and the building for the State, War, and Navy Departments	2,500.00	
For changing route of pipe line that supplies the Capitol, encasing a portion of it in concrete and uncovering and examining the entire line	10,000.00	
		12,500.00
Telegraph to connect the Capitol with the Departments and the Government Printing Office:		
For replacing the present system of wires with a duplicate 6-wire underground telegraph cable, being a total distance of about 17,000 feet	25,000.00	
For care and repair of existing lines, including replacing present poles with new and taller poles at a cost of $1,600, if the underground line is not constructed	3,100.00	
		28,100.00
Total		335,641.40

Washington Monument, elevator, electric lights, and machinery connected therewith.

The following estimate for operating the elevator, the electric lights, and the machinery connected therewith for the fiscal year ending June 30, 1895, is submitted:

One custodian, at $100 per month	$1,200
One steam engineer, at $90 per month	1,080
One assistant steam engineer, at $70 per month	840
One fireman, at $60 per month	720
One assistant fireman, at $60 per month	720
One conductor of elevator car, at $75 per month	900
One attendant on floor, at $60 per month	720
One attendant on top floor, at $60 per month	720
Three night and day watchmen, at $60 per month each	2,160
For fuel, lights, oil, waste, packing, tools, matches, paints, brushes, brooms, lanterns, rope, nails, screws, lead, electric lights, heating apparatus, oil stoves for elevator car and upper and lower floors, repairs to engines, boilers, dynamo, elevator, and repairs of all kinds connected with the monument and machinery, and purchase of all necessary articles for keeping the monument, machinery, elevator, and electric-light plant in good order.	3,000
Total	12,060

As some of the foregoing estimates are larger than the amounts heretofore appropriated, and as others are for new work, it is deemed advisable to submit the following brief explanation in reference thereto:

First. One public gardener, $2,000. I have asked for an increase in the salary of the public gardener, a position now so satisfactorily filled by Mr. George H. Brown. The duties of the office require that the gentleman who fills it shall be thoroughly skilled in the culture of trees, shrubs, and plants, and shall have a practical knowledge of civil engineering as applied to landscape gardening. Mr. Brown combines these attributes, to which he adds taste, industry, and integrity. His duties take him from one end of the city to the other. He is directly responsible for the care of the valuable collection of plants in the propagating

gardens, and superintends the propagation of plants that are annually raised for the public grounds, which this year numbered about 400,000.

Second. One clerk in charge of old public records of Washington City, $1,500. These records include maps, deeds, record books, letters, etc., from the organization of the original board of commissioners, near the close of the last century, up to 1867, when the duties were turned over to the Chief of Engineers. They are constantly examined by attorneys and others interested in lands in Washington, and the person in charge of them is frequently required to produce them in courts; to index them properly, to be able to turn at once to the details of any question raised, requires familiarity with every paper. This work has for the last few years been intrusted to the only draftsman allowed this office, and during the past year at least one-fourth of his time has been actually employed on this duty. It is desirable that this appropriation be made in order that the draftsman may be permitted to attend to the necessary and legitimate duties of his office.

Third. One clerk, $1,400. Of late years the office work has increased to such an extent that to properly perform it has required continuous work at night and on Sundays and holidays. This is a hardship, and as a remedy an appropriation for an additional clerk is recommended.

Fourth. For one telegraph lineman, $1,080. The telegraph system under charge of this office includes about 8 miles of overhead wire. There are 18 offices connected with these lines, the main battery being at this office. The lineman is constantly engaged in the care of the main and local batteries and such necessary repairs and extensions as a system of wires of this kind requires. He is industrious, efficient, and capable, and has won the confidence of all with whom he has come in contact by faithful attention to his duties.

Fifth. An increase in the appropriation for overseers, foremen, etc., is suggested, as the city of Washington is spreading to the north, east, and west, the area of improved reservations must be increased to keep pace with private enterprise, and the small increase requested will be of the utmost advantage in continuing the ornamentation of spaces now entirely unimproved.

Sixth. An estimate for a captain of the watch is submitted and recommended. Such an officer is much needed in order that the park watchmen may be under proper supervision.

Seventh. Estimates for a day watchmen for Marion and Folger squares and adjacent reservations, and for a day watchman for Garfield Park, are submitted and recommended. Marion and Folger squares contain an aggregate area of about 3 acres, and Garfield Park contains an area of about 24 acres. They are highly improved and the necessity for providing watchmen for their care is apparent.

Eighth. An estimate is submitted for a day watchman at Rawlins Square and adjacent reservations. Rawlins Square is a large, highly improved park on New York avenue between Eighteenth and Nineteenth streets. It is about seven squares from Washington Circle and there are several highly improved reservations just north of it on Pennsylvania avenue. It is frequented to a large extent by the people living south and east of the reservation.

Ninth. For the care and improvement of the Monument grounds, $10,000. It is desirable that this important improvement should progress more rapidly than heretofore. The amount ($2,000) appropriated for 1894 was sufficient merely to maintain the park in its present condition, and did not admit of any improvements in the unfinished portions of the grounds.

Tenth. For painting watchmen's lodges, iron fences, vases, lamps, and lamp-posts $1,500 is requested. There are 8 watchmen's lodges, a number of post-and-chain fences, 18 vases, over 400 lamp-posts, and the iron fence around the Executive Mansion, all of which should be painted in 1895–'96.

Eleventh. For trees, tree and plant stakes, etc., and stock for nursery $3,000 is asked, in place of the $2,000 last granted. The larger sum is the amount appropriated annually for more than twelve years, ending June 30, 1892.

Twelfth. For removing snow and ice the sum of $1,500 is asked. The sum usually granted, viz, $1,200, is generally sufficient, but sometimes is not.

Thirteenth. Twenty thousand dollars is asked for improvement, care, and maintenance of various reservations, in place of the $10,000 granted this year. It is proposed to improve as many as possible of the unimproved reservations. Each year from one to five are added to the list of improved reservations, and if the funds now requested become available eight or ten can be added during the fiscal year ending June 30, 1896. As reservations are thus improved the expense of the care of the whole is slightly increased, for the improvements must be maintained.

Fourteenth. For the Smithsonian grounds $8,000 is asked, and for Judiciary Square $7,000, in place of $2,500 and $3,000 granted last year. The increased amounts can be profitably expended during the fiscal year ending June 30, 1896, in the improvement of those parks.

Fifteenth. For placing granite curbing about Franklin Square $5,000 is asked. The beauty of this handsome park will be greatly enhanced by placing around it a granite curbing similar to those used around parks of the same style in the larger cities elsewhere.

Sixteenth. For laying asphalt walks in various reservations, $5,000. It is proposed to replace with first-class asphalt walks the gravel paths in Washington Circle, Mount Vernon Square, Executive Mansion grounds (south side), Lincoln Square, Stanton Square, Folger Square, Marion Square, Henry and Seaton parks, and to renew those in Farragut Square. In the late fall, winter, and early spring those walks are muddy, and pedestrians seek the lawns, which are thus destroyed by trespassers. The amount of these paths which it is proposed to lay is about 3,500 square yards. Each autumn it becomes necessary to put down plank walks, which must again be removed in the spring. If asphalt walks are laid, the annual expense incident to plank walks will be avoided.

Seventeenth. For improvement, care, and maintenance of Henry (Armory) and Seaton parks, $5,000. These reservations, extending from Seventh street to the Botanic Gardens, cover an area of 34 acres, with road and walk surfaces of over 10,000 square yards. They are in an advanced state of improvement. Their beauty has been marred by the depot and tracks of the Baltimore and Potomac Railroad. A mound has been constructed around the depot, upon which it is intended to plant trees and shrubs, so that in time the depot will be hidden partially from view. The materials for this mound have thus far been obtained free of expense to the United States, and it is now proposed to complete the grading of the mound and to seed and plant it. The funds requested are needed for this purpose and for the care of roads, lawns, gutters, etc., and laying out additional paths.

Eighteenth. An estimate amounting to $6,000 is also submitted for constructing a large greenhouse at the propagating gardens for palms

and subtropical plants. The greenhouse structures now existing at the gardens are of small size and not of sufficient capacity to accommodate that class of plants.

Nineteenth. An estimate amounting to $25,000 is submitted for improving the reservation known as Howard University Park. The park contains an area of about 12 acres, and the reasons for recommending its improvement are mentioned in this report.

Twentieth. For lodges for park watchmen in Stanton, Mount Vernon, Iowa, Dupont, Thomas, McPherson, and Folger reservations, at $500 each, $3,500. The watchmen in these reservations are exposed to the inclemency of the weather at all seasons of the year. Rain or shine, hot or cold, night or day, year in and out, they must be at their stations and take shelter, when necessary, either under a tree or in such a dwelling or store as will offer its hospitality. The dictates of humanity call for this appropriation.

Twenty-first. The sum of $200 is asked for repairing pedestals and cleaning statues. Several of the pedestals need repointing, and the statues are from time to time disfigured by bird lime, which must be removed.

Twenty-second. Estimates are submitted for the improvement of the reservations at the corner of Pennsylvania avenue and Fourteenth street, $5,000, and Hancock Place, corner Pennsylvania avenue and Seventh street, $3,000; these are prominent places, upon the principal avenue in the city, and it is urgently hoped that funds may be appropriated for their improvement and ornamentation.

Twenty-third. An estimate is submitted for the improvement of Reservation No. 19, near the navy-yard, as requested by certain citizens of Southeast Washington; plans for beautifying this park at an estimated cost of $12,000 have been prepared, and it is hoped that the necessary funds for the work will be appropriated.

Twenty-fourth. An estimate of $10,500 is submitted for the construction of an asphalt walk, 15 feet wide, on the outer border of the ellipse in the grounds south of the Executive Mansion.

This ellipse is now used for drills, parades, etc., while the wide road around it has become a resort for those who can afford the use of carriages and horses. In order that pedestrians may be able to enjoy the privilege of watching these reviews and parades, as well as the pleasure of evening promenades during the heated period over a walk which will be used as a public thoroughfare, it is urged that this appropriation may be made.

Twenty-fifth. For expenses, including advertising, of sale of old, condemned, and useless property, $100.

Section 3618 of the Revised Statutes requires that condemned property shall be sold at public auction. Disbursing officers must comply with the rulings of the accounting officers of the Treasury. The First Comptroller of the Treasury has decided that the *gross* proceeds of sale of condemned property of this kind must be turned into the Treasury, the expenses of the sale to be paid from the general appropriation for the particular Department that may have used this old material, condemned stores, etc. The Second Comptroller of the Treasury has decided that only the *net* proceeds of the sale must be turned into the Treasury, the expenses of the sales to be paid from the proceeds derived therefrom. We have here diametrically opposite decisions on the same subject from the two Comptrollers, from whose decisions there appears to be no appeal.

With the exception of one other officer besides myself, I believe every

officer of the Corps of Engineers disbursing under the Chief of Engineers has final action upon his accounts through the Second Comptroller, and pays the expenses of sales of this kind out of the proceeds of the sale. I must, however, pay such expenses under the decision of the First Comptroller from the appropriations under my charge. As these appropriations are absolutely necessary for the purposes for which they were made, I ask that a specific sum be appropriated for the expenses of this sale.

It would be equally advantageous if, in the law making appropriations for this department, a proviso similar to that appertaining to some other departments could be inserted, as follows: Provided, That hereafter the expenses of the sale at public auction of all condemned and useless property appertaining to the public buildings and grounds in the District of Columbia, under charge of the Chief of Engineers, shall be paid from the funds derived from the sale.

Twenty-sixth. New superstructure of iron and glass for the conservatory of the Executive Mansion, $13,000.

The present wooden superstructure constructed some years ago is badly decayed and in a dangerous condition. It has been patched and otherwise repaired from time to time, but should be replaced by an entire new modern structure.

Twenty-seventh. The appropriation requested for lighting Executive Mansion and public grounds, and which is in excess of that made last year, is deemed very necessary in order to extend the electric-light system through the Monument grounds, now entirely without illumination, and to change the system in Lafayette and Franklin parks from gas to electric lights. In the interest of morality, as well as for the protection of persons visiting or passing through the parks after dark, it is desirable to make them as light as possible at night.

Twenty-eighth. An estimate of $10,000 is submitted for changing the route of the pipe line which supplies the Capitol with pure spring water, incasing a portion of it in concrete and examining the entire line; the necessity for this important work is fully set forth in this report.

Twenty-ninth. An estimate is again submitted for replacing the overhead wires between the Capitol and the Departments with a duplicate underground 6-wire cable. The growth of the trees on the sidewalks renders it absolutely necessary, in order to maintain telegraphic communication over these wires, either to erect at once taller poles at a cost of about $1,600, or to lay an underground cable at a cost of $25,000. It appears to be the will of Congress that no more overhead wires shall be placed in this city (see District of Columbia appropriation act of July 18, 1888); otherwise I should recommend the appropriation of the smaller amount.

Thirtieth. I recommend that the salaries of the two steam engineers at the Washington Monument be increased from $80 and $60 to $90 and $70 per month, respectively. The duties of these two men are of great importance. Upon their efficiency and intelligence depend, to a great extent, the lives of those who use the elevator. The increase asked is small and the men deserve it. I also recommend that the pay of the two firemen be placed at $60 per month each. That is the rate allowed firemen in the Executive Departments, and there appears to be no reason why the firemen at the Monument should receive less.

In submitting these estimates I earnestly recommend that the various items under the heading of "Improvement and care of public grounds" be aggregated under one head, and while each item of work

shall be named, the whole shall be covered by a general sum, not a specific sum for each item. This is done in other Departments of the Government, particularly the Quartermaster's Department of the Army. It saves quite an amount of clerical labor by permitting the preparation of accounts under one heading, rather than under about thirty; moreover, it permits small balances which might be saved from one item to be used in some other equally necessary and important work.

This recommendation is based strictly upon business principles, and is for the purpose of reducing clerical labor and expediting the progress of the work.

Financial statement for fiscal year ending June 30, 1894.

Title of appropriation.	Year.	Available at beginning of fiscal year.	Expended during fiscal year.	Pledged by contracts.	Unexpended balance to revert to Treasury.
Improvement and care of public grounds	1894	$44, 200. 00	$43, 915. 65		$284. 35
Repairs, fuel, etc., Executive Mansion	1894	27, 000. 00	25, 916. 33		1, 083. 67
Lighting, etc., Executive Mansion, etc	1894	15, 022. 00	14, 769. 29		252. 71
Repairs to water pipes and fire plugs	1894	2, 500. 00	2, 493. 63		6. 37
Telegraph to connect the Capitol with the Departments and Government Printing Office.	1894	1, 250. 00	1, 250. 00		
Contingent expenses, public buildings and grounds under Chief Engineer	1894	500. 00	497. 98		2. 02
Salaries of employés, public buildings and grounds under Chief Engineer	1894	47, 060. 00	46, 981. 02		78. 98
Care and maintenance of the Washington Monument	1894	11, 520. 00	11, 489. 05		30. 95
Ford's Theater building, repairs		*17, 958. 00	16, 163. 91		
Pedestal for statue of Gen. John A. Logan		50, 000. 00	2, 000. 00	$48, 000. 00	
Pedestal for statue of Gen. Winfield Scott Hancock		49, 00. 000	2, 000. 00	47, 000. 00	

*Appropriated by act approved September 7, 1893, $6,000; by act approved March 12, 1894, $11,958.

In conclusion, I desire to express my sincere appreciation of the faithful and efficient manner in which Mr. George H. Brown, the skillful and accomplished public gardener, and Mr. E. F. Concklin, overseer and chief clerk, have performed the various and important duties committed to their charge.

I am, general, very respectfully, your obedient servant,

JOHN M. WILSON,
Lieut. Col., Corps of Engineers,
Colonel, U. S. Army.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SYNOPSIS OF UNITED STATES PUBLIC RESERVATIONS IN THE CITY OF WASHINGTON, DISTRICT OF COLUMBIA, TO ACCOMPANY ANNUAL REPORT UPON PUBLIC BUILDINGS AND GROUNDS, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

Number, area, location, and description of the Government parks and reservations comprising the public grounds of Washington, D. C., under the control of the Chief of Engineers, U. S. Army.

Description.	Number.	Area.
		Acres.
Total number of reservations	301	405. 08
Reservations highly improved	92	350. 38
Reservations partially improved	41	6. 01
Reservations unimproved	168	48. 69

In this report and upon the map herewith the reservations are numbered in the following order:

1. Pennsylvania avenue	20 to 56	12. New Jersey avenue	190 to 196
2. Massachusetts avenue	57 to 93	13. Maryland avenue	197 to 213
3. Virginia avenue	94 to 130	14. Delaware avenue	214 to 228
4. New Hampshire avenue	131 to 148	15. North Carolina avenue	229 to 239
5. Connecticut avenue	149 to 150	16. South Carolina avenue	240 to 241
6. Rhode Island avenue	151 to 160	17. Georgia avenue	242 to 258
7. Vermont avenue	161 to 170	18. Kentucky avenue	259 to 265
8. New York avenue	171 to 185	19. Tennessee avenue	266 to 269
9. Ohio avenue	186	20. Florida avenue	270 to 283
10. Louisiana avenue	187	21. Canal street	284 to 293
11. Indiana avenue	188 to 189	22. Water street	294 to 301

No. 1. *President's Park* (formerly *White lot*; area, 82 acres 9,683 square feet; highly improved):

Between Fifteenth and Seventeenth streets west and B street and Pennsylvania avenue north. The Executive Mansion, United States Treasury, State, War, and Navy Department buildings are located on the northern portion of this reservation, in separate inclosures, surrounded by iron railings and flag-stone pavements. These inclosed spaces are laid out in asphalt walks and lawn surfaces, are well lighted and interspersed with ornamental evergreen and deciduous trees and shrubs, and parterres for summer planting of exotic flowering and foliaged plants. The southern portion of the park, except a limited area still occupied by the stables of the Executive Mansion, has been improved. Gravel roads and walks have been laid out for public travel, the lawn surfaces have been arranged, and the planting of the ground with natural groups of ornamental green and deciduous trees and shrubs has been nearly completed. The roadway around the ellipse is lighted from 7 electric lamps. There are 3 fountains, 1 on the north front, 1 on the east front, and 1 on the south front of the Executive Mansion. The east and west carriageways leading to the north front of the Executive Mansion are now laid in asphalt.

No. 2. *Washington Park* (formerly the *Monument Grounds*; area, 78 acres 22,678 square feet; highly improved):

Between Fourteenth and Seventeenth streets west and B street north and B street south and the old bank of the Potomac River. This area includes the nursery grounds under control of this office and the lakes on the northwestern portion of the grounds under the control of the U. S. Fish Commission.

The Washington Monument is located near the river front in the western portion of the park. The white marble lodge is located near Fourteenth street, and the monument-elevator boiler-house near the old bank of the Potomac River.

A portion of the main roads of the park has been laid out for public travel and the lawn surface graded and planted in part with evergreen and deciduous trees. The nursery and propagating garden of the public gardens is in an advanced stage of improvement and comprises an area of about 7 acres. The carp ponds, lakes, and grounds, under control of the Fish Commission, comprise an area of about 20 acres.

A circular sidewalk is formed around the base of the monument at a radius of 70 feet from its center, and laid in granolithic pavement; a foot-walk from the northwest corner of the monument leading to Meridian avenue is laid in asphalt, and 5 feet in width of asphalt has been laid on the center of the gravel walk leading from the northeast corner of the monument in the direction of Fifteenth street west and B street north. Several flower beds are laid out in the triangles formed by the intersections of roads and walks; water has been introduced in part.

No 3. *Smithsonian Park* (area, 58 acres 1,260 square feet; highly improved):

Between Seventh and Twelfth streets west and from B street north to B street south. The Smithsonian Institution, the National Museum, and the Army Medical Museum and library are located in this park. These grounds are in an advanced stage of improvement; inclosed in part with a substantial iron railing; gas lamps around and on main lines of travel through the park; gravel and asphalt roads and walks in good condition; broad lawn surfaces planted with a choice selection of evergreen and deciduous trees and shrubs. The statue of the late Prof. Henry, by W. W. Story, is located at the intersection of the main roadways northwest of the Institute building and the monument to the late Prof. A. J. Downing is located near the north end of east ellipse in these grounds. Two drinking fountains and a watchman's lodge are located in this park, and irragation water is introduced throughout the park.

No. 4. *Henry Park* (formerly *Armory Park;* area, 14 acres 37,830 square feet; highly improved):

Between Sixth and Seventh streets west and B street north and B street south. The Baltimore and Potomac Railroad passenger depot and the Armory building (now used by the U. S. Fish Commission) are located in this park. These grounds are now in an advanced stage of improvement; inclosed in part with a substantial iron railing; gas lamps around and on main lines of travel through the park; gravel roads and walks in good condition; lawn surfaces partly planted with ornamental evergreen and deciduous trees and shrubs. The main roadway of this park is continued over Sixth street on a substantial iron bridge constructed by the Baltimore and Potomac Railroad Company. A large mound is being constructed, which will be planted with evergreen and deciduous trees and shrubs to screen the depot from the park.

No. 5. *Seaton Park* (area, 12 acres 21,902 square feet; highly improved):

Between Four-and-a-half and Sixth streets west and Maine and Missouri avenues.

These grounds are in an advanced stage of improvement; gas lamps around and on main lines of travel through the park; gravel roads and walks in good condition; lawn surfaces partly planted with ornamental evergreen and deciduous trees and shrubs.

No. 6. *Seaton Park* continued (area, 6 acres 19,440 square feet; highly improved):

Between Third and Four-and-a-half streets west and Maine and Missouri avenues. These grounds are in an advanced stage of improvement; gas lamps around and on main lines of travel through the park; gravel road and walks in good condition; lawn surfaces partly planted with ornamental evergreen and deciduous trees and shrubs. There is 1 drinking fountain in this park.

No. 7. *Judiciary Park*, area 19 acres 35,712 square feet; highly improved):

Between Fourth and Fifth streets west and Indiana and Louisiana avenues and G street north. The City Hall and new Pension Office buildings are located in this park. These grounds are in an advanced stage of improvement and partly inclosed with post-and-chain fence; gas lamps around and on main lines of travel through the park; watchman's lodge with public conveniences, 2 drinking fountains, and 1 jet fountain are in this park; general roads and walks in good condition; lawn surfaces planted with ornamental evergreen and deciduous trees, and shrubs and flower beds in front of watchman's lodge. The entrance road to the east end of the the Pension Office building, and walks leading to and passing the building, and the walk from Fourth and E streets and from watchman's lodge to the Pension Office building and from Fourth to Fifth streets west and from Fourth and F streets to City Hall and Louisiana avenue and from Fourth street west and Indiana avenue to the City Hall are laid in asphalt; water for irrigating purposes has been introduced.

No. 8. *Mount Vernon Park* (area, 2 acres 27,673 square feet; highly improved):

Between Seventh and Ninth streets northwest, at the intersection of Massachusetts and New York avenues. This park is improved and planted with ornamental evergreen and deciduous trees and shrubs; inclosed with post and chain fence; gas lamps around and through the park; two drinking fountains and one ornamental iron jet fountain in the center of the park; gravel and asphalt walks on direct lines of travel through the park, and lawn surfaces interspered with flower beds for summer planting of exotic flowering and foliage plants.

No. 9. *Franklin Park* (area, 4 acres 28,590 square feet; highly improved):

Between Thirteenth and Fourteenth streets west and I and K streets north. Gas lamps through the park; two drinking fountains and a watchman's lodge, with public conveniences, and a fountain in the center of the park, with a set of French jets and ornamental polished Aberdeen granite coping; lawn surfaces planted with choice ornamental evergreen and deciduous trees and shrubs, and interspersed with beds and borders for summer planting of decorative flowering and foliaged plants; asphalt and gravel walks on lines of travel through the park.

No. 10. *Lafayette Park* (area, 6 acres 41,444 square feet; highly improved):

Between Pennsylvania avenue and H street north and Fifteen-and-a-half and Sixteen-and-a-half streets west. This park, from its prominent situation opposite the main front of the Executive Mansion, was one of the first city parks elaborately improved and planted, and contains a choice collection of evergreen and deciduous trees and shrubs, including many fine specimens of rare species not generally found north of Wash-

ington; gas lamps around and through the park; two drinking fountains; lawn surfaces planted chiefly on margins of walks and interspersed with flower beds and borders for summer planting of exotic flowering and foliaged plants. Two massive antique bronze vases of elaborate design on granite pedestals grace the park at intersections of walks near the eastern and western entrances. The equestrian statue of Gen. Jackson, by Clark Mills, on a white marble pedestal, surrounded by four field pieces of artillery (captured by Gen. Jackson), occupies the center of the park; gravel and asphalt walks are in good condition, and a watchman's lodge, with necessary public conveniences, is located in this park.

The statue of Gen. Lafayette and his compatriots, by Messrs. Alexander Falguiere and Antonin Mercie, of France, graces the southeast entrance to this park; two granite pier posts, with wing walls and coping, have been placed at this entrance to the park, and a granite boundary curb, with terminal granite-block piers at entrances to walks has been set around the park.

No. 11. *McPherson Park* (area, 1 acre 29,216 square feet; highly improved):

Between I and K streets north, at the southeastern terminus of and intersection of Vermont avenue and Fifteenth street west. These grounds are in an advanced stage of improvement; the lawn surfaces are planted with ornamental evergreen and deciduous trees and shrubs. The equestrian statue of Gen. McPherson, by Louis I. Rebisso, occupies the center of the park; two large ornamental iron flower vases are placed on the lawns and planted with suitable summer decorative plants; asphalt walks intersect the grounds on direct lines of travel through the park; gas lamps around and through the park. Two drinking fountains are placed at intersections of walks near the center, and a granite boundary curb around the margin of the park.

No. 12. *Farragut Park* (area, 1 acre 26,216 square feet; highly improved):

Between I and K streets north and terminus and intersection of Connecticut avenue and Seventeenth street west. The bronze statue of Admiral Farragut, by Mrs. Vinnie Ream Hoxie, is located in the center of this park; lawn surfaces are planted with evergreen and deciduous trees and shrubs, and interspersed with flower beds, etc.; asphalt walks are laid out in diagonal lines, and a drinking fountain placed at intersection of the walks; gas lamps are around and through the park; inclosed with post-and-chain fence.

No. 13. *Rawlins Park* (area, 1 acre 30,218 square feet; highly improved):

Between Eighteenth and Nineteenth streets west and at the intersection of New York avenue and E street north. This park is inclosed with post-and-chain fence; improved and planted with evergreen and deciduous trees and shrubs; lawn surfaces planted chiefly on margins of walks; two rustic fountains are located near the eastern and western entrances; asphalt walks are laid out in direct lines of travel; gas lamps are around the park.

No. 14. *Lincoln Park* (area, 6 acres 25,284 square feet; highly improved):

Between Eleventh and Thirteenth streets east and at the intersection of Kentucky, Tennessee, North Carolina, and Massachusetts avenues. The bronze statue of "The Emancipation," by Thomas Ball, is located in this park. These grounds are in an advanced stage of improvement; inclosed with post-and-chain fence; gas lamps around the park and on lines of walks through it; lawn surfaces planted with choice evergreen and deciduous trees and shrubs, interspersed with flower beds, etc.; gravel walks on needed lines of travel are in good condition. There are two drinking fountains and a watchman's lodge, with public conveniences, in the park. Two ornamental fountains (spray jets and Portland cement stone copings and basins) are placed at northern and southern entrances to this park.

No. 15. *Stanton Park* (area, 3 acres 2,145 square feet; highly improved):

Between Fourth and Sixth streets east and at the intersection of Massachusetts and Maryland avenues. The bronze equestrian statue of Gen. Greene, by Henry K. Brown, is located here. The park is inclosed with post-and-chain fence; gas lamps are through the park; lawn surfaces planted with choice evergreen and deciduous trees and shrubs; gravel walks on direct lines of travel, flower beds are laid out at the base of the pedestal of the statue for summer planting of decorative flowering plants; two ornamental rustic fountains are located at intersection of walks.

No. 16. *Folger Park* (area, 1 acre 39,654 square feet; highly improved):

Between Second and Third streets east and at the intersection of North Carolina avenue and D street south. This park is on the north front of

Providence Hospital and is inclosed with post-and-chain fence; gas lamps around and through the park; gravel walks on direct lines of travel and the lawn surfaces are planted with deciduous trees; there is also a rustic granite fountain in the center of the park.

No. 17. *Garfield Park* (area, 23 acres 42,691 square feet; highly improved):
Between South Capitol street and Third street east and at the intersection of New Jersey and Virginia avenues. These grounds are in an advanced stage of improvement; gravel roads and walks on direct lines of travel. The lawn surface is fully graded. The eastern section is planted with a choice collection of evergreen and deciduous trees and shrubs, and interspersed with flower beds. The western section is only planted in part; irrigating water has been introduced throughout the park.

No. 18. *Marion Park* (area, 1 acre 26,840 square feet; highly improved):
Between Fourth and Sixth streets east at the intersection of South Carolina avenue and E street south. These grounds have been highly improved; gas lamps placed around and through the park; gravel walks constructed on direct lines of travel, and lawn surfaces planted with evergreen and deciduous trees and shrubs. There is a handsome large Hilton iron vase in this park.

No. 19. Rectangle (area, 3 acres 1,145 square feet; unimproved).
Between Fifth and Seventh streets east and K and L streets south, occupied in part by a railway track leading into the U. S. Washington navy-yard, as per act of Congress, dated March 2, 1889.

No. 20. Rectangle (area, 11 acres 13,810 square feet; unimproved):
Between Four-and-a-half and Sixth streets west and College and Pomeroy streets north, partly planted with deciduous trees of large growth, and sodded.

No. 21. Rectangle (area, 2 acres 36,181 square feet; unimproved):
Between Twentieth and Twenty-first streets west and B street north and the Potomac River.

No. 22. Triangle (area, 3,502 square feet; highly improved):
Between Twenty-eighth and Twenty-ninth streets west and at the intersection of Pennsylvania avenue and M street north. Lawn planted with suitable deciduous trees and shrubs, having a large, ornamental iron jet fountain, and inclosed with park post-and-chain fence.

No. 23. Triangle (area, 2,275 square feet; highly improved):
Between Twenty-fifth and Twenty-sixth streets west, at the intersection of Pennsylvania avenue and L street north. Inclosed with post-and-chain fence; improved, and planted mainly with flowering dwarf trees and shrubs.

No. 24. Triangle (area, 6,240 square feet; partially improved):
Between Twenty-fourth and Twenty-fifth streets west and at the intersection of Pennsylvania avenue and L street north. Inclosed with a post-and-chain fence; graded, but not planted; water introduced.

No. 25. Trapezoid (area, 1,365 square feet; highly improved):
Between Twenty-third and Twenty-fourth streets west and at the intersection of Pennsylvania avenue and K street north. Inclosed with post-and-chain fence, and lawn surface graded; flower bed in center of space and water introduced.

No. 26. *Washington Circle* (area, 1 acre 36,865 square feet; highly improved):
At the intersection of Pennsylvania and New Hampshire avenues and K and Twenty-third streets northwest. These grounds are in a highly improved condition, and are encircled by a granite curbing; gravel or asphalt walks on convenient lines of travel are in good condition; gas lamps around and through the park; lawn surfaces planted with choice evergreen and deciduous trees and shrubs and interspersed with flower beds for summer decorative planting of flowering and foliage plants; there is a watchman's lodge in this park and two drinking fountains. This is the site of the equestrian statue of Gen. Washington, by Clark Mills.

No. 27. Trapezoid (area, 2,232 square feet; partially improved):
Between Twenty-second and Twenty-third streets west and at the intersection of Pennsylvania avenue and K street north. Inclosed with a post-and-chain fence, lawn surface graded, and water introduced.

No. 28. Trapezoid (area, 17,688 square feet; highly improved):
Between Twentieth and Twenty-first streets west and at the intersection of Pennsylvania avenue and I street north. Inclosed with post-and-chain fence; improved and planted with choice evergreen and deciduous trees and shrubs; gas lamps around park; drinking fountain at the eastern end, and a rose-jet fountain in the center of the park; gravel walks are laid diagonally through the park; one iron flower vase near the east end of the grounds.

No. 29. Trapezoid (area, 14,338 square feet; highly improved):
Between Twentieth and Twenty-first streets west and at the intersection of Pennsylvania avenue and I street north. Inclosed with a post-and-chain fence; planted in part with deciduous trees and shrubs; lawn graded, soiled, and in grass, and a large bed of summer flowering plants in the center of the grounds.

No. 30. Triangle (area, 18,511 square feet; highly improved):
Between Eighteenth and Nineteenth streets west and at the intersection of Pennsylvania avenue and H street north. Inclosed with a post-and-chain fence; planted with deciduous and evergreen trees and shrubs; there is a rustic fountain with rose jet in the center; gas lamps around, and concrete walks through the park; a flower bed is constructed in the park.

No. 31. Triangle (area, 14,749 square feet; highly improved):
Between Eighteenth and Nineteenth streets west and at the intersection of Pennsylvania avenue and H street north. Inclosed with post-and-chain fence; planted with deciduous and evergreen trees and shrubs, and with two flower beds.

No. 32. Trapezoid (area, 16,270 square feet; partially improved):
Between Thirteen-and-a-half and Fourteenth streets west and at the intersection of Pennsylvania avenue and E street north. These grounds are graded and in grass, and partly planted with deciduous trees and water introduced; it is anticipated that they will be highly improved at an early day.

No. 33. Trapezoid (area, 21,012 square feet; highly improved):
Between Thirteenth and Fourteenth streets west and Pennsylvania avenue and E street north. The surface of this space was raised several feet in the center and regraded and soiled; asphalt walks on lines of travel and a triangular fountain basin, capped with an ornamental coping of Euclid, Ohio, dressed stone, were constructed; lawn planted with ornamental evergreen and deciduous trees and shrubs; one large iron flower vase has been placed in position, and irrigating water introduced; a low granite curbing surrounds the reservation.

The commission created by act of Congress approved March 2, 1889 (25 Stats., p. 971), has selected this space for the statue of the late Gen. Philip H. Sheridan.

No. 34. Trapezoid (area, 7,678 square feet; highly improved):
Between Ninth and Tenth streets west and at the intersection of Pennsylvania avenue and Ninth street. Inclosed with post-and-pipe-rail fence; ornamental cast-iron fountain in the center; Portland cement pavement around and through the park.

No. 35. Triangle (area, 5,529 square feet; highly improved):
Between Eighth and Ninth streets west and at the intersection of Pennsylvania and Louisiana avenues. The bronze statue of Gen. John A. Rawlins, by A. Bailey, is now located in this park. Inclosed with post-and-pipe-rail fence; lawn planted with deciduous trees of large growth; water introduced, and asphalt walks through park.

No. 36. Trapezoid (area, 15,138 square feet; highly improved):
Between Seventh and Eighth streets west and at the intersection of Pennsylvania and Louisiana avenues and C street north. The surface of this space was raised several feet in the center, and regraded and resoiled, and gravel walks constructed; lawn surfaces were planted with ornamental evergreen and deciduous trees and shrubs; two large ornamental iron flower vases are placed at intersections of walks, and irrigating water introduced; a granite curb surrounds the reservation.

The commission created by act of Congress approved March 2, 1889 (25 Stats., p. 972), has selected this space for the statue of the late Gen. Winfield Scott Hancock.

No. 37. Triangle (area, 5,189 square feet; highly improved):
Between Second and Third streets east and at the intersection of Pennsylvania avenue and B street south. Inclosed with post-and-chain fence lawn surface arranged, a flower bed in the center, and water introduced.

No. 38. Triangle (area, 13,360 square feet; highly improved):
Between Fourth and Fifth streets east and at the intersection of Pennsylvania and North Carolina avenues. Inclosed with post-and-pipe-rail fence; lawn surface arranged with a flower bed in the center; planted in part with a few shrubs and trees, and water introduced.

No. 39. Trapezoid (area, 12,100 square feet; highly improved):
Between Fourth and Fifth streets east and at the intersection of Pennsylvania and North Carolina avenues. Inclosed with post-and-pipe-rail fence; lawn surface arranged with a flower bed in the center and planted in part, and water introduced.

No. 40. Triangle (area, 3,685 square feet; highly improved):
Between Fourth and Fifth streets east and at the intersection of Pennsylvania and North Carolina avenues. Inclosed with post-and-pipe-rail fence; lawn surface arranged with flower bed in the center and planted in part, and water introduced.

No. 41. Trapezoid (area, 3,933 square feet; highly improved):
Between Fifth and Sixth streets east and at the intersection of Pennsylvania and North Carolina avenues. Inclosed with a post-and-pipe-rail fence; planted in part; lawn surface arranged with flower bed in the center, and water introduced.

No. 42. Triangle (area, 11,070 square feet; highly improved):
Between Fifth and Sixth streets east and at the intersection of Pennsylvania and North Carolina avenues. Inclosed with a post-and-pipe-rail fence; lawn surface arranged with a flower bed in the center; planted in part, and water introduced.

No. 43. Triangle (area, 13,855 square feet; highly improved):
Between Fifth and Sixth streets east and at the intersection of Pennsylvania and North Carolina avenues. Inclosed with a post-and-pipe-rail fence; lawn surface arranged with flower bed in the center, a few shrubs planted, and water introduced.

No. 44. Triangle (area, 14,960 square feet; highly improved):
Between Seventh and Eighth streets east and at the intersection of Pennsylvania and South Carolina avenues. Inclosed with a post-and-pipe-rail fence; lawn surface arranged with a flower bed in center; a few shrubs and trees planted; water introduced.

No. 45. Triangle (area, 13,030 square feet; highly improved):
Between Seventh and Eighth streets east and at the intersection of Pennsylvania and South Carolina avenues and D street south. Inclosed with post-and-pipe-rail fence; lawn surface arranged with a flower bed in the center; water introduced, and partly planted.

No. 46. Triangle (area, 1,450 square feet; highly improved:)
Between Seventh and Eighth streets east and at the intersection of Pennsylvania avenue and D street south. Inclosed with post-and-pipe-rail fence; lawn surface arranged.

No. 47. Triangle (area, 1.100 square feet; partially improved):
Between Eighth and Ninth streets east and at the intersection of Pennsylvania and South Carolina avenues and D street south. Graded and in grass.

No. 48. Triangle (area, 11,440 square feet; highly improved):
Between Eighth and Ninth streets east and at the intersection of Pennsylvania avenue and D street south. Inclosed with post-and-chain fence; lawn surface arranged with flower bed in the center; a few shrubs planted, and water introduced.

No 49. Triangle (area, 16,019 square feet; highly improved):
Between Eighth and Ninth streets east and at the intersection of Pennsylvania and South Carolina avenues. Lawn surface arranged, sown with grass seed, and water introduced; inclosed with a post-and-chain fence, and a flower bed and shrubs planted.

No. 50. Triangle (area, 4,618 square feet; highly improved):
Between Tenth and Eleventh streets east and at the intersection of Pennsylvania avenue and E street south. Lawn surface arranged, sown with grass seed, and water introduced; inclosed with post-and-chain fence, and a flower bed in the center.

No. 51. Triangle (area, 7,456 square feet; highly improved):
Between Eleventh and Twelfth streets east and at the intersection of Pennsylvania avenue and E street south; inclosed with post-and-chain fence; lawn surface arranged and in grass.

No. 52. Trapezoid (area, 10,962 square feet; unimproved):
Between Twelfth and Thirteenth streets east and at the intersection of Pennsylvania avenue and G street south.

No. 53. Triangle (area, 6,800 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Pennsylvania avenue and G street south.

No. 54. Rectangle (area, 1 acre 4,788 square feet; unimproved):
Between Thirteenth and Fifteenth streets east and at the intersection of Pennsylvania and Georgia avenues south.

No. 55. Segment of circle (area, 1 acre 13,165 square feet; unimproved).
At the junction of Pennsylvania avenue with the Eastern Branch bridge and on the south side of that avenue.

No 56. Segment of circle (area. 2 acres 11,080 square feet; unimproved):
At the junction of Pennsylvania avenue with the Eastern Branch bridge and on the north side of the avenue.

No. 57 Triangle (area, 2,435 square feet; partially improved):
Between Twenty-first and Twenty-second streets west and at the intersection of Massachusetts avenue and Q street north. Lawn surface arranged and sodded.

No. 58. Triangle (area, 3,177 square feet; highly improved):
Between Twenty-first and Twenty-second streets west and at the intersection of Massachusetts avenue and Q street north. Inclosed with post-and-chain fence; planted with deciduous trees and shrubs; a large Warwick iron vase placed in the center, and water introduced.

No. 59. Trapezoid (area, 8,363 square feet; highly improved):
Between Nineteenth and Twentieth streets west and at the intersection of Massachusetts avenue and P street north. Inclosed with post-and-chain fence; graded, sodded, an ornamental fountain placed in the center, and water introduced.

No. 60. *Dupont Circle* (area, 2 acres 2,722 square feet; highly improved):
Between Eighteenth and Twentieth streets west and at the intersection of Massachusetts, Connecticut, and New Hampshire avenues. The pedestal and statue of Rear-Admiral Dupont, by Mr. Launt Thompson, is located in the center of this park. These grounds have been improved, and planted with a choice collection of dwarf ornamental flowering trees and shrubs; a number of evergreen and deciduous trees of large growth have also been planted. Inclosed with post-and-chain fence: gas lamps through the circle; two drinking fountains at intersection of walks; lawn surface interspersed with flower beds; water introduced, and asphalt walks laid on direct lines of travel through the circle.

No. 61. Trapezoid (area, 2,200 square feet; unimproved):
Between Eighteenth and Nineteenth streets west, and at the intersection of Massachusetts avenue and P street north.

No. 62. Trapezoid (area, 13,964 square feet; highly improved):
Between Sixteenth and Seventeenth streets west and at the intersection of Massachusetts and Rhode Island avenues. Inclosed with post-and-chain fence; lawn surface, planted mainly with specimen dwarf trees and assorted varieties of flowering shrubs; flower bed in the center, and water introduced.

No. 63. *Scott Circle* (area, 7,851 square feet; highly improved):
At the intersection of Massachusetts and Rhode Island avenues and Sixteenth street west. This circle is the site of the bronze statue of Gen. Winfield Scott, by Henry K. Brown. Improved and planted; flower beds laid out on the lawn surface and at the base of the statue; gas lamps and flagstone pavement around the circle, and water introduced.

No. 64. Trapezoid (area, 13,725 square feet; highly improved):
Between Fifteenth and Sixteenth streets west and at the intersection of Massachusetts and Rhode Island avenues north. Inclosed with post-and-chain fence; lawn surface planted with dwarf ornamental evergreen and deciduous trees and flowering shrubs; flower bed in the center; gas lamps and stone pavement around the park, and water introduced.

No. 65. Trapezoid (area, 3,190 square feet; highly improved):
Between Fourteenth and Fifteenth streets west and at the intersection of Massachusetts avenue and M street north. Inclosed with a light iron railing; improved and partly planted.

No. 66. *Thomas Circle* (area, 28,352 square feet; highly improved):
At intersection of Massachusetts and Vermont avenues and Fourteenth street west. This circle is the site of the bronze equestrian statue of Gen. George H. Thomas, by J. Q. A. Ward. The grounds are improved; flower beds laid out in the lawn surface; gas lamps around the circle; a flagstone pavement also surrounds the circle, and water has been introduced.

No. 67. Trapezoid (area, 3,560 square feet; highly improved):
Between Thirteenth and Fourteenth streets west and at the intersection of Massachusetts avenue and M street north. Inclosed with wooden-post and pipe-rail fence, graded and sodded, and planted in part.

No. 68. Trapezoid (area, 16,819 square feet; highly improved):
Between Eleventh and Twelfth streets west and at the intersection of Massachusetts avenue and L street north. Inclosed with post-and-chain fence; planted with evergreen and deciduous trees and shrubs,

mainly of dwarf growth; asphalt walks are laid on direct lines of travel; flower beds laid out at intersections of walks; gas lamps are around the park and a drinking fountain located at its eastern end; two large ornamental flower vases are placed in suitable positions, and water has been introduced.

No. 69. Trapezoid (area, 17,686 square feet; highly improved):
Between Tenth and Eleventh streets west and at the intersection of Massachusetts avenue and L streets north. Inclosed and improved in a similar manner to No. 68 (the reservation before described), and situated just opposite and having one large ornamental flower vase.

No. 70. Trapezoid (area, 6,794 square feet; highly improved):
Between Ninth and Tenth streets west and at the intersection of Massachusetts and New York avenues and K street north. Inclosed with iron railings and planted with trees and flowering shrubs.

No. 71. Trapezoid (area, 5,812 square feet; highly improved):
At the intersection of Massachusetts avenue, Seventh street west, and K street north. Inclosed with post-and-chain fence; flower bed in the center of lawn surface and water introduced; gas lamps and flagstone pavement around the park.

No. 72. Trapezoid (area, 18,000 square feet; highly improved):
Between Fifth and Sixth streets west and at the intersection of Massachusetts avenue and I street north. Inclosed with post-and-chain fence; planted mainly with low-growing, ornamental trees and shrubs; two flower beds laid out and water introduced.

No. 73. Triangle (area, 625 square feet; partially improved):
Between Fourth and Fifth streets west and at the intersection of Massachusetts avenue and I street north. Graded and in grass.

No. 74. Trapezoid (area, 10,887 square feet; highly improved):
At the intersection of Massachusetts avenue and I street north and Fifth street west. Inclosed with post-and-chain fence; gravel walks in direct lines of travel; planted mainly with low-growing trees and shrubs and water introduced.

No. 75. Triangle (area, 5,400 square feet; highly improved):
At the intersection of Massachusetts avenue and H street north and between Third and Fourth streets west. Inclosed with post-and-pipe-rail fence; graded and sown in grass; water introduced and planted in part.

No. 76. Triangle (area, 7,320 square feet; highly improved):
Between Third and Fourth streets west and at the intersection of Massachusetts avenue and H street north. Water introduced and planted in part; inclosed with post-and-pipe-rail fence; graded and sown in grass.

No. 77. Circle (area, 15,393 square feet; partially improved):
Between North Capitol and First streets west and at the intersection of Massachusetts and New Jersey avenues. Graded and in grass; water introduced; inclosed with post-and-chain fence, and planted in part.

No. 78. Triangle (area, 4,725 square feet; unimproved):
Between North Capitol and First streets west and at the intersection of Massachusetts avenue and F street north.

No. 79. Triangle (area, 1,205 square feet; unimproved):
Between North Capitol and First streets east and at the intersection of Massachusetts avenue and F street north.

No. 80. Triangle (area, 1,205 square feet; partially improved):
At the intersection of Massachusetts and Delaware avenues and First street east. Graded and sown in grass.

No. 81. Triangle (area, 4,062 square feet; unimproved):
Between First and Second streets east and at the intersection of Massachusetts avenue and E street north.

No. 82. Triangle (area, 4,418 square feet; partially improved):
Between Second and Third streets east and at the intersection of Massachusetts avenue and D street north. Graded and in grass, and partially planted.

No. 83. Trapezoid (area, 4,915 square feet; partially improved):
At the intersection of Massachusetts avenue, D street north, and Third street east. Graded and sodded and in grass.

No. 84. Trapezoid (area, 9,594 square feet; highly improved):
Between Sixth and Seventh streets east and at the intersection of Massachusetts avenue and B street north. Inclosed with post-and-chain fence, graded and in grass, and water introduced and flower bed in center of space.

No. 85. Trapezoid (area, 8,506 square feet; unimproved):
Between Eighth and Ninth streets east and at the intersection of Massachusetts avenue and B street north.

No. 86. Trapezoid (area, 8,007 square feet; highly improved):
Between Eighth and Ninth streets east and at the intersection of Massachusetts avenue and A street north. Graded and seeded in grass, flower bed in center, water introduced, and inclosed with post-and-chain fence.

No. 87. Triangle (area, 960 square feet; partially improved):
Between Ninth and Tenth streets east and at the intersection of Massachusetts avenue and A street north. Graded and in grass.

No. 88. Triangle (area, 10,042 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Massachusetts avenue and A street south.

No. 89. Trapezoid (area, 8,505 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Massachusetts avenue and B street south.

No. 90. Triangle (area, 10,011 square feet; unimproved):
Between Fourteenth and Fifteenth streets east and at the junction of Massachusetts and South Carolina avenues southeast.

No. 91. Triangle (area, 7,651 square feet; unimproved):
Between Fourteenth and Fifteenth streets east and at the intersection of Massachusetts avenue and B street south.

No. 92. Triangle (area, 18,351 square feet; unimproved):
Between Seventeenth and Eighteenth streets east and at the intersection of Massachusetts avenue and C street south.

No. 93. Triangle (area, 11,178 square feet; unimproved):
Between Eighteenth and Nineteenth streets east and at the intersection of Massachusetts avenue and C street south.

No. 94. Triangle (area, 1,574 square feet; unimproved):
Between Twenty-seventh and Twenty-eighth streets west and at the intersection of Virginia avenue and I street north.

No. 95. Triangle (area, 787 square feet; unimproved):
Between H and I streets north and at the intersection of Virginia avenue and Twenty-seventh street west.

No. 96. Triangle (area, 1,750 square feet; unimproved):
Between Twenty-sixth and Twenty-seventh streets west and at the intersection of Virginia avenue and H street north.

No. 97. Triangle (area, 1,875 square feet; unimproved):
Between Twenty-fifth and Twenty-sixth streets west and at the intersection of Virginia avenue and H street north.

No. 98. Triangle (area, 8,640 square feet; unimproved):
Between Twenty-fourth and Twenty-fifth streets west and at the intersection of Virginia avenue and G street north.

No. 99. Triangle (area, 4,897 square feet; unimproved):
Between Twenty-fourth and Twenty-fifth streets west and at the intersection of Virginia avenue and G street north.

No. 100. Triangle (area, 6,164 square feet; unimproved):
Between Twenty-third and Twenty-fourth streets west and at the intersection of Virginia avenue and F street north.

No. 101. Trapezoid (area, 2,394 square feet; unimproved):
Between Twenty-second and Twenty-third streets west and at the inter section of Virginia avenue and F street north.

No. 102. Triangle (area, 4,234 square feet; unimproved):
Between Twenty-first and Twenty-second streets west and at the intersection of Virginia avenue and E street north.

No. 103. Triangle (area, 1,312 square feet; unimproved):
Between Twenty-first and Twenty-second streets west and at the intersection of Virginia avenue and E street north.

No. 104. Triangle (area, 1,450 square feet; unimproved):
Between Twenty-first and Twenty-second streets west and at the intersection of Virginia avenue and D street north.

No. 105. Triangle (area, 11,096 square feet; unimproved):
Between Twentieth and Twenty-first streets west and at the intersection of Virginia and New York avenues.

No. 106. Triangle (area, 11,467 square feet; unimproved):
Between Twentieth and Twenty-first streets west and at the intersection of Virginia and New York avenues.

No. 107. Triangle (area, 1,950 square feet; unimproved):
Between Nineteenth and Twentieth streets west and at the intersection of Virginia avenue and D street north.

No. 108. Triangle (area, 1,323 square feet; unimproved):
Between Nineteenth and Twentieth streets west and at the intersection of Virginia avenue and C street north.

No. 109. Triangle (area, 1,180 square feet; unimproved):
Between Eighteenth and Nineteenth streets west and at the intersection of Virginia avenue and C street north.

No. 110. Triangle (area, 7,250 square feet; unimproved):
Between Seventeenth and Eighteenth streets west and at the intersection of Virginia avenue and B street north.

No. 111. Trapezoid (area, 10,237 square feet; highly improved):
Between Eleventh and Twelfth streets west and at the intersection of Virginia avenue and B street south. Inclosed with post-and-chain fence; planted with evergreen and deciduous trees and shrubs and water introduced.

No. 112. Trapezoid (area, 8,695 square feet; unimproved):
Between Ninth and Tenth streets west and at the intersection of Virginia avenue and C street north.

No. 113. Rectangle (area, 2 acres 11,376 square feet; partially improved):
Between Seventh and Ninth streets west and at the intersection of Maryland and Virginia avenues. The tracks of the Baltimore and Potomac Railroad intersect this space, occupying about one-half of it, and, it is believed, in violation of law. The other half is inclosed with a post-and-chain fence, roughly graded, and sown in grass.

No. 114. Trapezoid (area, 10,428 square feet; unimproved):
Between Sixth and Seventh streets west and at the intersection of Virginia avenue and C street south.

No. 115. Trapezoid (area, 8,075 square feet; unimproved):
Between Sixth and Seventh streets west and at the intersection of Virginia avenue and D street south.

No. 116. Triangle (area, 4,625 square feet; partially improved):
Between Four-and-a-half and Sixth streets west and at the intersection of Virginia avenue and D street south. Inclosed with post-and-pipe-rail fence and partly planted; a flower bed in center.

No. 117. Triangle (area, 16,775 square feet; unimproved):
Between Four-and-a-half and Sixth streets west and at the intersection of Virginia avenue and D street south.

No. 118. Trapezoid (area, 14,414 square feet; unimproved):
Between Second and Third streets west and at the intersection of Virginia avenue and E street south.

No. 119. Triangle (area, 405 square feet; unimproved):
Between First and Second streets west and at the intersection of Virginia avenue and E street south.

No. 120. Trapezoid (area, 4,032 square feet; unimproved):
Between First street west and Delaware avenue and at the intersection of Virginia avenue and E street south.

No. 121. Triangle (area, 2,580 square feet; unimproved):
Between South Capitol and Half streets west and at the intersection of Virginia avenue and F street south. (The railroad side track into Marlow's coal yard passes through the center of this park by authority of act of Congress approved January 19, 1891.)

No. 122. Trapezoid (area, 15,916 square feet; unimproved):
Between Fourth and Fifth streets east and at the intersection of Virginia avenue and I street south.

No. 123. Triangle (area, 16,183 square feet; unimproved):
Between Sixth and Seventh streets east and at the intersection of Virginia avenue and I street south.

No. 124. Trapezoid (area, 9,828 square feet; unimproved):
Between Sixth and Seventh streets east and at the intersection of Virginia avenue and K street south.

No. 125. Trapezoid (area, 18,054 square feet; unimproved):
Between Eighth and Ninth streets east and at the intersection of Virginia avenue and K street south. (A public schoolhouse has been erected on this park; occupied, it is believed, without authority of law.)

No. 126. Rectangle (area, 1 acre 43,321 square feet; unimproved):
Between Ninth and Eleventh streets east and at the intersection of Virginia and Georgia avenues south.

No. 127. Trapezoid (area, 25,972 square feet; unimproved):
Between Eleventh and Twelfth streets east and at the intersection of Virginia avenue and L street south. Intersected longitudinally by the tracks of the Baltimore and Potomac Railway, it is believed, in violation of law.

No. 128. Triangle (area, 7,272 square feet; unimproved):
Between Twelfth and Thirteenth streets east and at the intersection of Virginia avenue and M street south.

No. 129. Triangle (area, 15,225 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Virginia avenue and M street south.

No. 130. Triangle (area, 3,932 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Virginia avenue and Water street southeast.

No. 131. Triangle (area, 1,298 square feet; unimproved):
Between Twenty sixth and Twenty-seventh streets west and at the intersection of New Hampshire avenue and E street north.

No. 132. Triangle (area, 1,268 square feet; unimproved):
Between Twenty-sixth and Twenty-seventh streets west and at the intersection of New Hampshire avenue and F street north.

No. 133. Triangle (area, 8,816 square feet; unimproved):
Between Twenty-fifth and Twenty-sixth streets west and at the intersection of New Hampshire avenue and G street north.

No. 134. Triangle (area, 9,426 square feet; unimproved):
Between Twenty-fifth and Twenty-sixth streets west and at the intersection of New Hampshire and Virginia avenues.

No. 135. Triangle (area, 1,014 square feet; unimproved):
Between Twenty-fourth and Twenty-fifth streets west and at the intersection of New Hampshire avenue and H street north.

No. 136. Triangle (area, 630 square feet; unimproved):
Between Twenty-fourth and Twenty-fifth streets west and at the intersection of New Hampshire avenue and I street north.

No. 137. Triangle (area, 1,750 square feet; unimproved):
Between I and K streets north and at the intersection of New Hampshire avenue and Twenty-fourth street west. Inclosed with a cast-iron railing fence and attached to St. Ann's Infant Asylum, it is believed in violation of law.

No. 138. Triangle (area, 2,200 square feet; partially improved):
Between K and L streets north and at the intersection of New Hampshire avenue and Twenty-second street west. Inclosed with a wire fence and in grass by owner of adjoining house, it is believed in violation of law.

No. 139. Triangle (area, 1,995 square feet; unimproved):
Between L and M streets north and at the intersection of New Hampshire avenue and Twenty-second street west.

No. 140. Triangle (area, 6,995 square feet; partially improved):
Between Twenty-first and Twenty-second streets west and at the intersection of New Hampshire avenue and M street north. Graded and in grass.

No. 141. Triangle (area, 1,536 square feet; unimproved):
Between M and N streets north and at the intersection of New Hampshire avenue and Twenty-first street west. Inclosed with an iron railing by owner of adjoining house, it is believed in violation of law.

No. 142. Triangle (area, 1,987 square feet; partially improved):
Between N and O streets north and at the intersection of New Hampshire avenue and Twentieth street west. Graded and in grass.

No. 143. Triangle (area, 988 square feet; unimproved):
Between Nineteenth and Twentieth streets west and at the intersection of New Hampshire avenue and O street north.

No. 144. Triangle (area, 12,264 square feet; highly improved):
Between Seventeenth and Eighteenth streets west and at the intersection of New Hampshire avenue and S street north. Graded, gravel walks constructed, trees and shrubs planted, and water introduced.

No. 145. Triangle (area, 3,838 square feet; highly improved):
Between Sixteenth and Seventeenth streets west and at the intersection of New Hampshire avenue and T street north. Graded, sown in grass, planted with trees and shrubs, and water introduced.

No. 146. Triangle (area, 5,400 square feet; unimproved):
Between Sixteenth and Seventeenth streets west and at the intersection of New Hampshire avenue and U street north.

No. 147. Triangle (area, 3,700 square feet; unimproved):
Between Fifteenth and Sixteenth streets west and at the intersection of New Hampshire avenue and Sixteenth street west.

No. 148. Triangle (area, 4,120 square feet; unimproved):
Between Fifteenth and Sixteenth streets west and at the intersection of New Hampshire avenue and Fifteenth street west.

No. 149. Triangle (area, 7,470 square feet; highly improved):
Between Nineteenth and Twentieth streets west and at the intersection of Connecticut avenue and Q street north. Graded and sown with grass seed, planted with evergreen and deciduous trees and shrubs, two flower beds constructed, and water introduced.

No. 150. Triangle (area, 6,435 square feet; highly improved):
Between Seventeenth and Eighteenth streets west and at the intersection of Connecticut avenue and M street north. Inclosed with post-and-chain fence; planted in part with evergreen and deciduous trees and shrubs; a flower bed in the center and water introduced.

No. 151. Triangle (area, 3,025 square feet; highly improved):
Between Seventeenth street and Connecticut avenue and at the intersection of Rhode Island avenue and M street north. Inclosed with post-and-chain fence, lawn graded and in grass, and planted with deciduous trees and shrubs.

No. 152. Trapezoid (area, 1,940 square feet; partially improved):
Between Thirteenth and Fourteenth streets west and at the intersection of Rhode Island avenue and P street north. Inclosed by owner of adjoining house, it is believed in violation of law.

No. 153. *Iowa Circle* (area, 2 acres 2,087 square feet; highly improved):
Between Twelfth and Fourteenth streets west and at the intersection of Vermont and Rhode Island avenues. Gas lamps through the circle; lawn surfaces planted with a choice collection of evergreen trees and shrubs. Asphalt walks are laid through the park. A large rose-jet fountain adorns the center, the coping and basin of which are made of artificial stone composed of Portland cement; two drinking fountains and four iron flower vases are placed at the intersections of walks, and there is a flower border around the main fountain, and water introduced. The commission created by act of Congress May 2, 1889 (25 Stats., p. 91), has selected this circle for the statue of Gen. John A. Logan.

No. 154. Triangle (area, 11,930 square feet; highly improved):
Between Twelfth and Thirteenth streets west and at the intersection of Rhode Island avenue and P street north. Inclosed with post-and-chain fence; planted with dwarf evergreen and deciduous trees and shrubs; water has been introduced.

No. 155. Trapezoid (area, 1,856 square feet; unimproved):
Between P and Q streets north and at the intersection of Rhode Island avenue and Tenth street west.

No. 156. Triangle (area, 868 square feet; highly improved):
Between Ninth and Tenth streets west and at the intersection of Rhode Island avenue and Q street north. Inclosed with post-and-chain fence and planted with flowering shrubs.

No. 157. Triangle (area, 9,185 square feet; highly improved):
Between Ninth and Tenth streets west and at the intersection of Rhode Island avenue and Q street north. Inclosed with post-and-chain fence, planted with evergreen and deciduous dwarf-growing trees and flowering shrubs, and water introduced.

No. 158. Triangle (area, 687 square feet; highly improved):
Between Sixth and Seventh streets west and at the intersection of Rhode Island avenue and R street north. Planted with deciduous trees, inclosed with post-and-chain fence, a flower bed in the center, and water introduced.

No. 159. Triangle (area, 6,630 square feet; unimproved):
Between Sixth and Seventh streets west and at the intersection of Rhode Island avenue and R street north.

No. 160. Triangle (area, 2,530 square feet; partially improved):
Between Fourth and Fifth streets west and at the intersection of Rhode Island and New Jersey avenues and S street north. Roughly graded, in grass, and planted with deciduous trees.

No. 161. Trapezoid (area, 960 square feet; partially improved):
Between L and M streets north and at the intersection of Vermont avenue and Fourteenth street west. Inclosed with an ornamental light wrought-iron railing; graded and in grass.

No. 162. Trapezoid (area, 960 square feet; partially improved):
Between M and N streets north and at the intersection of Vermont avenue and Fourteenth street west, at front of Martin Luther statue. Inclosed with post-and-pipe-rail fence; graded and in grass.

No. 163. Trapezoid (area, 7,700 square feet; highly improved):
Between O and P streets north and at the intersection of Vermont avenue and Thirteenth street west. Inclosed with post-and-chain fence, planted with low-growing evergreen and deciduous trees and shrubs, and water has been introduced.

No. 164. Trapezoid (area, 1,700 square feet; partially improved):
Between P and Q streets north and at the intersection of Vermont avenue and Thirteenth street west. Inclosed with an iron railing, graded and in grass by owner of adjoining house, it is believed in violation of law.

No. 165. Triangle (area, 2,467 square feet; partially improved):
Between Twelfth and Thirteenth streets west and at the intersection of Vermont avenue and R street north. Roughly graded; inclosed with a wooden fence.

No. 166. Trapezoid (area, 3,150 square feet; partially improved):
Between R and S streets west and at the intersection of Vermont avenue and Twelfth street west. Roughly graded and in grass.

No. 167. Triangle (area, 3,300 square feet; partially improved):
Between Eleventh and Twelfth streets west and at the intersection of Vermont avenue and S street north. Roughly graded and in grass

No. 168. Triangle (area, 4,087 square feet; partially improved):
Between Tenth and Eleventh streets west and at the intersection of Vermont avenue and Eleventh street west; roughly graded and in grass.

No. 169. Trapezoid (area, 3,045 square feet; partially improved):
Between S and T streets north and at the intersection of Vermont avenue and Tenth street west. Inclosed with an iron railing, and in grass, by owner of adjoining house; it is believed in violation of law.

No. 170. Triangle (area, 11,695 square feet; partially improved):
Between Ninth and Tenth streets west and T and U streets north and at the intersection of Vermont avenue and Tenth street west. Inclosed with post-and-chain fence, graded, and in grass.

No. 171. Triangle (area, 8,170 square feet; unimproved):
Between Twenty-second and Twenty-third streets west and at the intersection of New York avenue and C street north.

No. 172. Trapezoid (area, 3,967 square feet; highly improved):
Between Thirteenth and Fourteenth streets west and at the intersection of New York avenue and H street north. Inclosed with post-and-chain fence, planted in part with deciduous trees and flowering shrubs, a flower bed in the center, and water introduced.

No. 173. Trapezoid (area, 12,840 square feet; highly improved):
Between Eleventh and Twelfth streets west and at the intersection of New York avenue and I street north. Inclosed with a post-and-chain fence; lawn surface planted with low-growing evergreen and deciduous trees and flowering shrubs, a flower bed in center, and water introduced.

No. 174. Trapezoid (area, 13,482 square feet; highly improved):
Between Tenth and Eleventh streets west and at the intersection of New York avenue and I street north. Inclosed with post-and-chain fence; planted with evergreen and deciduous trees and shrubs; a flower bed and a terra-cotta fountain basin (carved Paris stone center piece and umbrella jet) are located in this park.

No. 175. Trapezoid (area, 5,450 square feet; highly improved):
Between Ninth and Tenth streets west and at the intersection of New York avenue and K street north. Inclosed with post-and-chain fence; planted with low-growing deciduous trees and shrubs, a flower bed in the center of the lawn, and water introduced.

No. 176. Trapezoid (area, 5,960 square feet; highly improved):
Between Sixth and Seventh streets west and at the intersection of New York avenue and K street north. Inclosed with post-and-chain fence; planted with evergreen and deciduous dwarf trees and flowering shrubs; a flower bed in the center and water introduced.

No. 177. Trapezoid (area, 540 square feet; partially improved):
Between Fifth and Sixth streets west and at the intersection of New York avenue and L street north; rough graded and partly planted.

No. 178. Trapezoid (area, 7,181 square feet; unimproved):
Between Fourth and Fifth streets west and at the intersection of New York avenue and L street north.

No. 179. Trapezoid (area, 9,061 square feet; highly improved):
Between Third and Fourth streets west and at the intersection of New York and New Jersey avenues and M street north. Inclosed with a light iron railing; planted with deciduous trees and shrubs; a fountain with Richmond granite coping is in the center.

No. 180. Triangle (area, 620 square feet; partially improved):
At the intersection of New Jersey and New York avenues and M street north. Graded only.

No. 181. Triangle (area, 22,152 square feet; highly improved):
Between First and Second streets west and at the intersection of New York avenue and M street north. Inclosed with a post-and-chain fence; lawn in grass, and partly planted with trees and shrubs, and water introduced.

No. 182. Triangle (area, 4,712 feet; unimproved):
Between First street west and North Capitol street and at the intersection of New York avenue and N street north.

No. 183. Triangle (area, 4,712 square feet; unimproved):
Between First street east and North Capitol street and at the intersection of New York avenue and N street north.

No. 184. Triangle (area, 7,618 square feet; unimproved):
Between North Capitol and First streets east and at the intersection of New York avenue and O street north.

No. 185. Triangle (area, 7,618 square feet; unimproved):
Between First and Second streets east and at the junction of New York and Florida avenues and O street north.

No. 186. Triangle (area, 7,272 square feet; unimproved):
Between Thirteenth and Thirteen-and-a-half streets west and at the intersection of Ohio avenue and C street north. Bethany Chapel was built on this reservation over eighteen years ago; occupied, it was believed, without authority of law.

No. 187. Triangle (area, 4,028 square feet; partially improved):
Between Fifth and Sixth streets west and at the intersection of Louisiana avenue and D street north; graded and partly planted.

No. 188. Triangle (area, 3,718 square feet; highly improved):
Between Third and Fourth streets west and at the intersection of Indiana avenue and D street north. Graded and planted with deciduous trees and shrubs. Inclosed with post-and-chain fence and water introduced.

No. 189. Triangle (area, 2,296 square feet; unimproved):
Between First and Second streets west and at the intersection of Indiana avenue and C street north.

No. 190. Triangle (area, 6,450 square feet; unimproved):
Between P and Q streets north and at the intersection of New Jersey avenue and Fourth street west.

No. 191. Trapezoid (area, 5,735 square feet; unimproved):
Between Third and Fourth streets west and at the intersection of New Jersey avenue and O street north.

No. 192. Trapezoid (area, 8,550 square feet; unimproved):
Between Third and Fourth streets west and at the intersection of New Jersey avenue and N street north.

No. 193. Triangle (area, 9,386 square feet; highly improved):
At the intersection of New Jersey avenue and I street north and Second street west. Inclosed with post-and-chain fence; planted with evergreen and deciduous low-growing trees and shrubs, and water introduced.

No. 194. Trapezoid (area, 5,725 square feet; highly improved):
Between H and I streets north and at the intersection of New Jersey avenue and I street and Second street west. Inclosed with post-and-chain fence; walks and flower beds laid out; evergreen and deciduous trees and shrubs planted, and water introduced.

No. 195. Trapezoid (area, 12,572 square feet; partially improved):
Between G and H streets north and at the intersection of New Jersey avenue and First street west. Graded, sown in grass, and partly planted.

No. 196. Trapezoid (area, 5,170 square feet; partially improved):
Between E and F streets north and at the intersection of New Jersey avenue and First street west. Graded, sown in grass, and partly planted.

No. 197. Trapezoid (area, 4,402 square feet; unimproved):
Between Twelfth and Thirteenth streets west and at the intersection of Maryland avenue and D street south. Now occupied by the Baltimore and Potomac Railroad, it is believed in violation of law.

No. 198. Trapezoid (area, 5,029 square feet; unimproved):
Between Ninth and Tenth streets west and at the intersection of Maryland avenue and D street south. This reservation is occupied by the Baltimore and Potomac Railroad tracks, by authority of act of Congress approved January 19, 1891.

No. 199. Trapezoid (area, 4,132 square feet; unimproved):
Between Ninth and Tenth streets west and at the intersection of Maryland avenue and C street south.

No. 200. Trapezoid (area, 10,098 square feet; unimproved):
Between Sixth and Seventh streets west and at the intersection of Maryland avenue and C street south.

No. 201. Triangle (area, 22,095 square feet; unimproved):
Between Third and Four-and-a-half streets west and at the intersection of Maryland avenue, B and Canal streets south.

No. 202. *Garfield Circle* (area, 6,361 square feet; highly improved):
At the junction of Maryland avenue with First street southwest. The statue of James A. Garfield, late President of the United States, has been erected in this circle. The pedestal was erected by the United States and the statue by the Army of the Cumberland; lawns are divided by granolithic foot paths and water introduced.

No. 203. Triangle (area, 10,296 square feet; highly improved):
Between First and Second streets east and at the intersection of Maryland avenue and A street north. Inclosed with post-and-chain fence; graveled walks have been laid out and the lawns planted with low-growing trees and flowering shrubs; a flower bed in the center and water introduced.

No. 204. Triangle (area, 7,820 square feet; highly improved):
Between First and Second streets east and at the intersection of Maryland avenue and B street north. Inclosed with post-and-chain fence; graded, sodded, and partly planted; flower bed in center and water introduced.

No. 205. Triangle (area, 12,152 square feet; highly improved):
Between Second and Third streets east and at the intersection of Maryland avenue and B street north. Inclosed with post and chain fence; graded, sodded, and partly planted; a flower bed in the center and water introduced.

No. 206. Triangle (area, 4,860 square feet; unimproved):
Between Sixth and Seventh streets east and at the intersection of Maryland avenue and D street north.

No. 207. Trapezoid (area, 3,213 square feet; unimproved):
Between Seventh and Eighth streets east and at the intersection of Maryland avenue and D street north.

No. 208. Trapezoid (area, 3,720 square feet; unimproved):
Between Eighth and Ninth streets east and at the intersection of Maryland avenue and E street north.

No. 209. Trapezoid (area, 4,496 square feet; unimproved):
Between Tenth and Eleventh streets east and at the intersection of Maryland avenue and E street north.

No. 210. Triangle (area, 10,860 square feet; unimproved):
Between Eleventh and Twelfth streets east and at the intersection of Maryland avenue and F street north.

No. 211. Triangle (area, 4,588 square feet; unimproved):
Between Twelfth and Thirteenth streets east and at the intersection of Maryland avenue and F street north.

No. 212. Triangle (area, 4,095 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Maryland avenue and G street north.

No. 213. Triangle (area, 3,330 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Maryland avenue and G street north.

No. 214. Triangle (area, 2,100 square feet; unimproved):
Between O and P streets south and at the intersection of Delaware avenue and Third street west.

No. 215. Triangle (area, 6,039 square feet; unimproved):
Between Second and Third streets west and at the intersection of Delaware avenue and N street north.

No. 216. Trapezoid (area, 6,039 square feet; unimproved):
Between Second and Third streets west and at the intersection of Delaware avenue and M street south.

No. 217. Triangle (area, 552 square feet; unimproved):
Between L and M streets south and at the intersection of Delaware avenue and Second street west.

No. 218. Triangle (area, 2,100 square feet; unimproved):
Between K and L streets south and at the intersection of Delaware avenue and Second street west.

No. 219. Trapezoid (area, 25,642 square feet; unimproved):
Between I and K streets south and Delaware avenue and Second street west.

No. 220. Trapezoid (area, 11,340 square feet; unimproved):
Between I and H streets south and Delaware avenue and First street west.

No. 221. Triangle (area, 4,576 square feet; unimproved):
Between G and H streets south and at the intersection of Delaware avenue and First street west.

No. 222. Triangle (area, 405 square feet; unimproved):
Between F and G streets south and at the intersection of Delaware avenue and First street west.

No. 223. Trapezoid (area, 10,815 square feet; unimproved):
Between E and F streets south and Delaware avenue and First street west.

No. 224. Trapezoid (area, 25,240 square feet; highly improved):
At the intersection of Massachusetts and Delaware avenues, First street east and F street north. Inclosed with post-and-chain fence; has gravel walks, rustic fountain in the middle; lawns planted with evergreen and deciduous trees and shrubs, and a flower border around fountain.

No. 225. Triangle (area, 4,508 square feet; highly improved):
Between F and G streets north and at the intersection of Delaware avenue and First street east. Inclosed with post-and-chain fence and planted with trees and shrubs.

No. 226. Trapezoid (area, 23,482 square feet; unimproved):
Between G and H streets north and at the intersection of Delaware avenue and First street east. Occupied by the Baltimore and Ohio Railway Company for a freight yard, it is believed in violation of law.

No. 227. Triangle (area, 4,628 square feet; unimproved):
Between L and M streets north and at the intersection of Delaware avenue and Second street east.

No. 228. Trapezoid (area, 7,093 square feet; unimproved):
Between M and N streets north and at the intersection of Delaware avenue and Second street east.

No. 229. Trapezoid (area, 9,702 square feet; partially improved):
Between First and Second streets east and at the intersection of North Carolina avenue and E street south. Roughly graded and in grass.

No. 230. Trapezoid (area, 16,368 square feet; unimproved):
Between Sixth and Seventh streets east and at the intersection of North Carolina avenue and B street south.

No. 231. Triangle (area, 506 square feet; partially improved):
Between A and B streets south and at the intersection of North Carolina avenue and Eighth street east. Graded and in grass.

No. 232. Trapezoid (area, 7,837 square feet; highly improved):
Between Eighth and Ninth streets east and at the intersection of North Carolina avenue and B street south. Inclosed with post-and-chain fence, a flower bed in the center, and water introduced.

No. 233. Trapezoid (area, 7,406 square feet; partially improved):
Between Eighth and Ninth streets east and at the intersection of North Carolina avenue and A street south. Inclosed with post-and-chain fence, roughly graded, and in grass.

No. 234. Triangle (area, 900 square feet; partially improved):
Between Ninth and Tenth streets east and at the intersection of North Carolina avenue and A street south. Roughly graded and in grass.

No. 235. Triangle (area, 10,556 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of North Carolina avenue and A street north.

No. 236. Trapezoid (area, 8,883 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of North Carolina avenue and B street north.

No. 237. Triangle (area, 600 square feet; unimproved):
Between Fourteenth and Fifteenth streets east and at the intersection of North Carolina avenue and B street north.

No. 238. Triangle (area, 7,698 square feet; unimproved):
Between Fourteenth and Fifteenth streets east and at the intersection of North Carolina avenue and B street north.

No. 239. Triangle (area, 10,351 square feet; unimproved):
Between Fifteenth and Sixteenth streets east and at the intersection of North Carolina avenue and C street north.

No. 240. Triangle (area, 5,642 square feet; unimproved):
Between Twelfth and Thirteenth streets east and at the intersection of South Carolina avenue and C street south.

No. 241. Triangle (area, 5,046 square feet; unimproved):
Between Twelfth and Thirteenth streets east and at the intersection of South Carolina avenue and C street south.

No. 242. Triangle (area, 21,900 square feet; unimproved):
Between Second and Third streets west and at the intersection of Georgia avenue and S street south.

No. 243. Triangle (area, 20,878 square feet; unimproved):
Between First and Second streets west and at the intersection of Georgia avenue and R street south.

No. 244. Triangle (area, 20,234 square feet; unimproved):
Between Half and First streets west and at the intersection of Georgia avenue and R street south.

No. 245. Triangle (area 24,727 square feet; unimproved):
Between South Capitol and Half streets west and at the intersection of Georgia avenue and Q street south.

No. 246. Triangle (area, 20,520 square feet; unimproved):
Between South Capitol and Half streets east and at the intersection of Georgia avenue and Q street south.

No. 247. Triagle (area, 30,975 square feet; unimproved):
Between Half and First streets east and at the intersection of Georgia avenue and P street south.

No. 248. Triangle (area, 1,500 square feet; unimproved):
Between First and Second streets east and at the intersection of Georgia avenue and O street south.

No. 249. Triangle (area, 5,180 square feet; unimproved):
At the intersection of Georgia avenue and Fourth and N streets SE. Occupied as a lumber yard, it is believed in violation of law.

No. 250. Triangle (area, 1,827 square feet; unimproved):
At the intersection of Georgia avenue, N, Fifth, and Canal streets SE.

No. 251. Triangle (area, 10,914 square feet; unimproved):
Between Eighth and Ninth streets east and at the intersection of Georgia avenue and M street south.

No. 252. Triangle (area, 10,700 square feet; unimproved):
Between Eleventh and Twelfth streets east and at the intersection of Georgia avenue and K street south.

No. 253. Triangle (area, 9,144 square feet; unimproved):
Between Twelfth and Thirteenth streets east and at the intersection of Georgia avenue and K street south.

No. 254. Triangle (area, 10,753 square feet; unimproved):
Between Twelfth and Thirteenth streets east and at the intersection of Georgia avenue and I street south.

No. 255. Trapezoid (area, 6,510 square feet; unimproved):
Between Fourteenth and Fifteenth streets east and at the intersection of Georgia avenue and G street south.

No. 256. Triangle (area, 3,937 square feet; unimproved):
Between Fifteenth and Sixteenth streets east and at the intersection of Georgia and Kentucky avenues and G street south.

No. 257. Triangle (area, 15,748 square feet; unimproved):
Between Seventeenth and Eighteenth streets east and at the intersection of Georgia avenue and E street south.

No. 258. Triangle (area, 8,972 square feet; unimproved):
Between Eighteenth and Nineteenth streets east and at the intersection of Georgia avenue and E street south.

No. 259. Triangle (area, 5,395 square feet; unimproved):
Between Twelfth and Thirteenth streets east and at the intersection of Kentucky avenue and B street south.

No. 260. Triangle (area, 3,850 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Kentucky avenue and B street south.

No. 261. Triangle (area, 2,116 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Kentucky avenue and D street south.

No. 262. Triangle (area, 2,010 square feet; unimproved):
Between Fourteenth and Fifteenth streets east and at the intersection of Kentucky avenue and D street south.

No. 263. Triangle (area, 1, 762 square feet; unimproved):
Between Fourteenth and Fifteenth streets east and at the intersection of Kentucky avenue and Fifteenth street east.

No. 264. Triangle (area, 2,592 square feet; unimproved):
Between Fifteenth and Sixteenth streets east and at the intersection of Georgia and Kentucky avenues and G street south.

No. 265. Triangle (area, 1,462 square feet; unimproved):
Between Fifteenth and Sixteenth streets east and at the intersection of Kentucky avenue and H street south.

No. 266. Triangle (area, 5,742 square feet; unimproved):
Between Twelfth and Thirteenth streets east and at the intersection of Tennessee avenue and B street north.

No. 267. Triangle (area, 6,348 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Tennessee avenue and B street north.

No. 268. Triangle (area, 5,043 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Tennessee avenue and D street north.

No. 269. Triangle (area, 3,250 square feet; unimproved):
Between Fourteenth and Fifteenth streets east and at the intersection of Tennessee avenue and E street north.

No. 270. Triangle (area, 877 square feet; unimproved):
At the intersection of Florida avenue and Twenty-first streets northwest.

No. 271. Triangle (area 687 square feet; partially improved):
At the intersection of Florida avenue and V street north and between Seventeenth and Eighteenth streets west. Inclosed with a wire fence; graded and in grass.

No. 272. Triangle (area, 437 square feet; unimproved):
At the intersection of Florida avenue and Tenth street northwest.

No. 273. Triangle (area, 418 square feet; unimproved):
Between Ninth and Tenth streets west, and at the intersection of Vermont avenue and V street north.

No. 274. Triangle (area, 350 square feet; partially improved):
Between Sixth and Seventh streets west, and at the intersection of Florida avenue and T street north. Inclosed with iron railing and in grass.

No. 275. Triangle (area, 870 square feet; unimproved):
Between Fourth and Fifth streets west, and at the intersection of Florida avenue and S street north.

No. 276. Triangle (area, 870 square feet; unimproved):
Between First and Third streets west, and at the intersection of Florida avenue and R street north.

No. 277. Triangle (area, 742 square feet; unimproved):
Between North Capitol street and First street west and at the intersection of Florida avenue and Q street north.

No. 278. Triangle (area, 960 square feet; unimproved):
Between North Capitol street and First street east, and at the intersection of Florida avenue and P street north.

No. 279. Triangle (area, 484 square feet; unimproved):
Between Third and Fourth streets east, and at the intersection of Florida avenue and N street north.

No. 280. Triangle (area, 725 square feet; unimproved):
Between Sixth and Seventh streets east and at the intersection of Florida avenue and M street north.

No. 281. Triangle (area, 700 square feet; unimproved):
Between Ninth and Tenth street east and at the intersection of Florida avenue and L street north.

No. 282. Trapezoid (area, 1,053 square feet; unimproved):
Between Eleventh and Twelfth streets east and at the intersection of Florida avenue and K street north.

No. 283. Triangle (area, 600 square feet; unimproved):
Between Thirteenth and Fourteenth streets east and at the intersection of Florida avenue and I street north.

No. 284. Triangle (area, 450 square feet; partially improved):
Between Canal street and at the intersection of B and Second streets southwest. Graded and in grass.

No. 285. Triangle (area, 10,500 square feet; unimproved):
Between Canal street and at the intersection of First and D streets southwest.

No. 286. Triangle (area, 1,905 square feet; partially improved):
At the intersection of Canal, South Capitol, and E streets southeast. The curbing and sidewalks have been laid. Graded and in grass.

No. 287. Triangle (area, 2,929 square feet; unimproved):
At the intersection of Canal street, H street south, Half street east. Now occupied by the Baltimore and Potomac Railroad Company, by act of Congress January 19, 1891.

No. 288. Trapezium (area, 11,462 square feet; unimproved):
Between H and I streets south, and at the intersection of New Jersey avenue, Canal, and First streets east. Now occupied by the Baltimore and Potomac Railroad Company by act of Congress dated January 19, 1891.

No. 289. Triangle (area, 1,520 square feet; unimproved):
At the intersection of New Jersey avenue, Canal and I streets s
Now occupied by the Baltimore and Potomac Railroad Compan
of Congress dated January 19, 1891.

No. 290. Triangle (area, 5,700 feet; unimproved):
At the intersection of South Capitol, I, and H streets southwest.

No. 291. Triangle (area, 2,280 square feet; unimproved):
At the intersection of I and Half streets southwest and on the we
the canal.

No. 292. Triangle (area, 8,125 square feet; unimproved):
Between L and M streets south and Half and First streets wes
west side of the canal.

No. 293. Triangle (area, 2,100 square feet; unimproved):
At the intersection of Canal and N streets south and First str
Ownership claimed by party who has erected a house upon it.
of ownership now before court.

No. 294. Triangle (area, 11,400 square feet; partially improved):
At the intersection of Water street, N street south, and Sixth str
Roughly graded.

No. 295. Triangle (area, 9,108 square feet; unimproved):
Between U and V streets south and at the intersection of Water s
Half street west.

No. 296. Triangle (area, 9,954 square feet; unimproved):
Between T and U streets south and at the intersection of Water
streets west.

No. 297. Triangle (area, 1,750 square feet; unimproved):
Between R and S streets south and at the intersection of South
and Water streets.

No. 298. Triangle (area, 3,250 square feet; unimproved):
Between Twelfth and Thirteenth streets east and at the intersec
and Water streets south.

No. 299. Triangle (area, 7,875 square feet; unimproved):
Between Fourteenth and Fifteenth streets east and at the inters
Water street and M street south.

No. 300. Triangle (area, 3,450 square feet; unimproved):
Between Fifteenth and Sixteenth streets east and at the inters
Water street and L street south.

No. 301. Triangle (area, 1,235 square feet; unimproved):
Between Fifteenth and Sixteenth streets east and at the inters
Water street and L street south.

APPENDIX D D D.

NORTHERN AND NORTHWESTERN LAKES—SURVEYS—CORRECTING ENGRAVED PLATES—PRINTING AND ISSUING OF CHARTS.

REPORT OF COL. O. M. POE, CORPS OF ENGINEERS, BVT. BRIG. GEN. U. S. A., FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 10, 1894.

SIR: I have the honor to transmit herewith, in duplicate, my annual report on the "Issue of the published charts of the Northern and Northwestern Lakes and surveys made for the purpose of keeping these charts up to date," for the fiscal year ending June 30, 1894. * * *

Very respectfully, your obedient servant,

O. M. POE,
Colonel, Corps of Engineers, Bvt. Brig. Gen., U. S. Army.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

D D D I.

NORTHERN AND NORTHWESTERN LAKES—SURVEYS—CORRECTING ENGRAVED PLATES—PRINTING AND ISSUING OF CHARTS.

The sundry civil act of March 3, 1893, appropriated the following amounts for the fiscal year ending June 30, 1894:

Survey of Northern and Northwestern Lakes.—For printing and issuing charts for use of navigators and electrotyping plates for chart printing, two thousand dollars.

For surveys, additions to, and correcting engraved plates, twenty-five thousand dollars.

Under the first item the issuing of charts has been done in Detroit, Mich., from this office, the rest of the work required being attended to by the office of the Chief of Engineers, in Washington. During the fiscal year nearly all charts have been sold at the uniform price of 20 cents each. A few special lithographic charts have been sold for 10 and 5 cents each, and some charts have been issued free of charge for the official use of Government agents applying for them.

The following table shows the extent of this business:

Issue of the charts of the Northern and Northwestern Lakes during the fiscal year ending June 30, 1894.

Description.	Number.	Total.
On hand July 1, 1893	4,264	
Received during the year	5,211	
		9,475
Issued to United States vessels, officials, etc	360	
Destroyed, worthless, not showing corrections to date	398	
Sold, at 20 cents each	4,542	
Sold, at 10 cents each	26	
Sold, at 5 cents each	3	
		5,329
On hand July 1, 1894		4,146

The sum of $911.15 was turned into the Treasury from sale of charts.

Total number of charts distributed to July 1, 1893	194,399
Distributed, etc., during fiscal year	4,931
Total distributed to July 1, 1894	199,330

Under the second item of the above appropriation a number of charts have had corrections and additions made upon them in this office, and have been forwarded to Washington in order that the necessary changes might be made upon the engraved plates.

The following charts have been amended in this office:

	Scale.
Detroit River	1: 40,000
Straits of Mackinac	1:120,000
Lake Huron	1:400,000
South End Lake Huron	1:120,000
Lake Erie	1:400,000
Coast Chart No. 4, Lake Erie	1: 80,000
Presque Isle and Middle Island, Lake Huron	1: 40,000

The information embodied in the above charts was derived from the best available sources of information. This work has been seriously impeded by lack of sufficient funds. The work is essential, however, if the charts are to be used for navigating the lakes.

The following progress on the combined chart of Lake Superior, scale 1:400,000, has been made: Completed 845 miles of inshore and offshore hydrography and 800 miles of shore line with the adjoining topography 3 to 5 miles back from shore, taking in the latest topographical and geographical information. The hydrography commences at Pigeon River, United States boundary line, and extends around the northwest coast and along the south shore to Pictured Rocks. The topography commences at Carltons Peak, on northwest shore and extends from this point to Pictured Rocks. The topography on the eastern end of Lake Superior and on both sides of St. Marys River, extending from Point Iroquois and Gros Cap to Little Rapids, has been reduced from resurvey, St. Marys River, 1893, and inked in.

Extensive alterations are being made to chart No. 1, St. Marys River, showing section 1 of the 20 and 21 foot Channel and the Hay Lake improvement. For this purpose the chart is being extended so as to take in Middle Neebish. The head of Collingwood Channel is also to be added to this chart. The cities of Sault Ste. Marie, Mich., and Ontario are to be reduced from the field sheets of the resurvey of St. Marys River, 1893. The alterations in this chart are very nearly completed.

Mr. Edward Molitor has had charge of this work, and when not engaged on other work has devoted his whole time to it, with his well-known intelligence and skill.

RESURVEY ST. MARYS RIVER.

The increase in the draft of vessels navigating the Great Lakes and their connecting waters has rendered the resurvey of certain localities necessary. A large number of artificial changes have been made in the channels and harbors, and data obtained fifty years ago in the narrow or rocky parts of the waterway is not sufficiently accurate for a navigation twice the depth of that at the time these surveys were made.

In conformity with the general plan of resurveying certain localities, a resurvey of St. Marys River was commenced in May, 1892, at an estimated cost of $64,080. Work was suspended on June 30, 1892, on account of the exhaustion of funds available. Four thousand dollars was allotted for fiscal year ending June 30, 1893, and $20,357.43 for fiscal year ending June 30, 1894. Work was resumed in January, 1893, and has been continued to date.

On June 30, 1893, a field observatory had been constructed at Sault Ste. Marie, Mich., on land belonging to the United States. The astronomical instruments and electrical apparatus necessary for the determination of latitude and longitude had been placed in position.

The observations for a fundamental determination of latitude had been made; eight primary stations definitely and four approximately located; a base line had been measured and the computations made; a line of precise levels had been run from Sault Ste. Marie to Bay Mills, Mich., and the computations nearly completed.

Contracts.

Contractor.	For—	Entered into—	Remarks.
The Richmond & Backus Co.	Stationery	Apr. 27, 1893	In force.
P. M. Church & Co.	Hardware, ship chandlery, etc.	....do	Closed Dec., 1893.
Prenzlauer Bros	Groceries	....do	Do.
Andrew Hotton	Meats	....do	Do.

OPERATIONS DURING THE FISCAL YEAR.

Astronomical work.—The computations for the latitude of the east pier of the observatory at Sault Ste. Marie were made. Latitude of east pier, 46° 30′ 06.25″ north. Reduced to west pier, 46° 30′ 06.27″ ± 0.08″; the latter latitude was used in the reduction of the triangulation. Observations for the difference in longitude between the west pier, Sault Ste. Marie Observatory, and Ann Arbor (meridian circle) were made and the computations completed. Sault Ste. Marie Observatory (west pier) west of Ann Arbor (meridian circle) 2 minutes 27.995 seconds ± 0.036 second. Taking the best obtainable data for the longitude of Ann Arbor, 5 hours 34 minutes 55.25 seconds west from Greenwich, we have Sault Ste. Marie Observatory (west pier) west from Greenwich 5 hours 37 minutes 23.25 seconds or 84° 20′ 48.75″. This value was used in the reduction of the triangulation. Observations and computations for the azimuth of the line Sault Ste. Marie Observatory to △ azimuth were made. Azimuth, 178° 06′ 38.87″. This value was used in the reduction of the triangulation.

Continuous latitude and azimuth.—For the purpose of obtaining additional data in regard to the recently-discovered movement of the pole,

an effort will be made to observe latitude and azimuth continuously for a few years. A table of latitude stars has been very carefully prepared for this work, and a programme has been determined upon for the azimuth observations. Assistant Engineers Ripley and Dixon, who are employed upon the river and harbor works in the vicinity, have volunteered for this work, but so far have been too busy to accomplish very much.

Triangulation.—A plan of triangulation connecting the triangulation of Lake Superior with that of the Straits of Mackinac was devised, but some reconnoitering is necessary to ascertain whether this plan or any other is practicable in order to make a complete connection between the two systems named above.

Eighteen primary and 12 secondary stations were built and the necessary lines of sight cut. The angles at 11 stations were measured; 20 measures each for 91 primary angles, and 8 measures each for 67 secondary angles were made.

In this work a direct connection was made with the river improvement tertiary triangulation at Stations Iroquois and South Gros Cap.

Topographical work.—In order to obtain the requisite topography for chart No. 3 of the adopted series of the new charts of the river in one season, two small topographical parties were placed in the field. These parties started at the lower end of the reach (just east of Sault Ste. Marie, Mich., and Ontario) and worked westward. On the American side, 51.4 square miles of territory were covered, and on the Canadian side 40 square miles. The average cost was about $60 per square mile. The survey shows all the features of the ground, 20-foot contours, land survey lines, etc.

Hydrography.—In connection with the operations of improving the ship channel 20 and 21 feet in depth between Chicago, Duluth, and Buffalo, a hydrographic survey of a large portion of the river adjacent to the localities where improvements are in progress, or are contemplated, has been begun. This survey will cover the reaches of the river shown on charts 2 and 3 of the adopted series of new charts. As this work, like all the "river and harbor" surveys, will be done with great care and accuracy, the lake survey will not duplicate it, and the soundings obtained will be used for the new charts.

Office work.—In addition to the computations for latitude, longitude, and azimuth, an adjustment of the completed triangulation was made, the geodetic coordinates of the various stations in the primary work and of the tertiary stations in the river improvement triangulation were made.

PROPOSED WORK.

The work already done will enable chart No. 3 of the new series to be issued when the hydrography shall have been completed. The next allotment will be expended in extending the triangulation, and, if sufficient, in obtaining enough information to permit the publication of chart No. 2. This will require the topographical and hydrographical work to be carried down the river from Sault Ste. Marie. It would be very desirable to have some accurate magnetic observations made during the progress of the survey, and it is thought that this can be done at small cost. Everything is now in readiness to push the work as fast as the necessary funds become available.

The resurvey of St. Marys River has been under the local charge of First Lieut. Charles S. Riché, Corps of Engineers, U. S. Army, assisted by Assistant Engineers Morley, Haskell, Von Schon, Molitor, and Balch, and Mr. Thomas Russell. In Lieut. Riché's report and the sub-

reports attached thereto can be found all the details connected with the prosecution of the work.

ANNUAL WATER LEVELS OF THE NORTHERN AND NORTHWESTERN LAKES.

Daily observations were made under my direction at Sand Beach, Mich., on Lake Huron, and at the head of St. Marys Falls Canal, Sault Ste. Marie, Mich.

The following table embodies the results:

Monthly mean of water levels for the following-named stations below the planes of reference adopted in 1876.

Stations.	1893						1894.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Sand Beach	3.50	3.64	3.93	4.14	4.37	4.57	4.62	4.61	4.46	4.23	3.83	3.53
Sault Ste Marie	2.808	2.724	2.854	2.913	2.968	3.504	3.725	3.809	3.919	3.528	2.556	2.316

ESTIMATE.

The resurvey of St. Marys River is now in progress and the work is being pushed as rapidly as available funds will permit. The traffic through the river is already so great, that the publication of new charts is becoming more and more essential every day. These charts would show to the navigator the new channels upon which the Government has been expending so much money, together with all ranges and landmarks along the shores. They would show the best courses for his vessel to run and the dangers to be avoided in the difficult navigation of this portion of one of the great commercial waterways of the world.

Throughout the lake region larger and larger vessels are being built each season. Their value to the general public is increasing every year, and nothing should be left undone in efforts looking toward the safety of these costly vessels and their cargoes.

The connecting channels of the lakes are now from 4 to 5 feet deeper than they were when the original surveys were made, and a still further increase in depth of 4 feet is approaching completion. When the new 20 and 21-foot channel is finished the depth in many places will be more than double what it was orginally. The increased draft of the vessels using these channels, combined with the low water of recent years, has caused the larger and more expensive vessels to discover dangers previously unsuspected, and to discover them by the costly process of striking them. All dangers so discovered should at once be surveyed and located upon the charts in order to prevent the repetition of similar accidents at the same point. Localities deemed perfectly safe for navigation when smaller vessels were used are now regarded with suspicion by the larger vessels, and it is essential that certain special areas be reexamined.

Accurate knowledge of dangerous obstructions can be obtained in but one way, and that is from charts. When the Government sells charts to navigators these charts should embody the latest and most accurate information concerning the localities to which they refer. It is essential, therefore, that all the charts be kept constantly up to date. The organized districts, in connection with the river and harbor work of the Corps of Engineers now established at the chief cities on the

lakes, will greatly facilitate this work, and will insure the maximum results with the minimum cost.

In the field work of the resurvey of St. Marys River alone $36,239.15 can be economically and profitably expended during the fiscal year ending June 30, 1896. In addition, the new charts of the river must be drawn, engraved, and printed. At the same time other localities must not be neglected. New shoals should be resurveyed as promptly as discovered. New light-houses, buoys, landmarks, channel improvements, etc., must be located and marked upon existing charts. This work is accumulating, and it increases the longer it is postponed. In view of all these facts an estimate is submitted of $75,000 for "surveys and other expenses connected with the correcting and extending the charts of the Northern and Northwestern lakes, to be available until expended," in full confidence that the conditions actually existing amply warrant this expenditure.

Estimate for the fiscal year ending June 30, 1896.

For printing and issuing charts for use of navigators and electrotyping plates for chart printing	$3,000.00
For surveys and other expenses connected with correcting and extending the charts, including resurvey of St. Marys River, to be available until expended	75,000.00
Total	78,000.00

Money statement.

RESURVEY OF ST. MARYS RIVER.

Allotted May 2, 1893, $20,000; February 17, 1894, $357.43	$20,357.43
June 30, 1894, amount expended during fiscal year	19,704.86
July 1, 1894, balance unexpended	652.57
July 1, 1894, outstanding liabilities	652.57
Amount (estimated) required for completion of existing project	36,239.15
Amount that can be profitably expended in fiscal year ending June 30, 1896	36,239.15

Dates and amounts of appropriations for survey of Northern and Northwestern Lakes.

March 3, 1841	$15,000
May 18, 1842	20,000
March 1, 1843	30,000
June 17, 1844	20,000
March 3, 1845	20,000
August 8, 1846	25,000
August 12, 1848	25,000
March 3, 1849	10,000
September 28, 1850	25,000
March 3, 1851	25,000
August 30, 1852	25,000
March 3, 1853	50,000
August 5, 1854	50,000
March 3, 1855	50,000
August 30, 1856	50,000
March 3, 1857	50,000
June 12, 1858	75,000
March 3, 1859	75,000
June 21, 1860	75,000
March 2, 1861	75,100
July 5, 1862	105,000
February 9, 1863	106,879
July 2, 1864	100,000
February 28, 1865	125,000
June 12, 1866	50,000
March 2, 1867	77,500
March 2, 1868	77,500
July 20, 1868	$75,000
March 3, 1869	100,000
July 15, 1870	100,000
March 3, 1871	175,000
June 10, 1872	175,000
March 3, 1873	175,000
June 23, 1874	175,000
March 3, 1875	150,000
July 31, 1876 (not including $16,000 applied to survey Mississippi River)	84,000
March 3, 1877 (not including $25,000 applied to survey Mississippi River and including $9,500 received from sale of steamers)	94,500
June 20, 1878 (not including $49,500 applied to survey of Mississippi River)	49,500
March 3, 1879	85,000
June 16, 1880	40,000
March 3, 1881	18,000
August 7, 1882	12,000
March 3, 1883	3,000
Total	2,942,879

Dates and amounts of appropriations for survey of Northern and Northwestern Lakes.

Printing and issue of charts for use of navigators and electrotyping copper plate for chart printing:

July 7, 1884	$3,000
March 3, 1885	3,000
August 4, 1886	2,000
March 3, 1887	2,000
October 2, 1888	2,000
March 2, 1889	2,000
August 30, 1890	2,000
March 3, 1891	2,000
August 5, 1892	2,000
March 3, 1893	2,000
Total	22,000

Dates and amounts of appropriations for survey of Northern and Northwestern Lakes.

Surveys and additions to and correcting engraved plates:

March 2, 1889	$5,000
August 30, 1890	10,000
March 3, 1891	10,000
August 5, 1892	5,000
March 3, 1893	25,000
Total	55,000

Abstract of bids for supplies for survey of Northern and Northwestern Lakes, received and opened March 28, 1894, in accordance with advertisement dated March 8, 1894.

No.	Name and address of bidder.	Supplies.	Total.
1	P. M. Church & Co., Sault Ste. Marie, Mich	Hardware, ship chandlery, etc	*$1,172.67
2	Robert G. Ferguson, Sault Ste. Marie, Mich	do	1,228.61
1	Prenzlauer Bros., Sault Ste. Marie, Mich	Groceries	*779.31
2	Allan Bros., Detroit, Mich	do	784.06
3	P. C. Keliher, Sault Ste. Marie, Mich	do	842.27
4	Peppard & McKinney, Sault Ste. Marie, Mich	do	868.30
5	Royce & Reynolds, Sault Ste. Marie, Mich	do	914.49
6	Otto Supe & Co., Sault Ste. Marie, Mich	do	914.69
7	Jno Blessed & Son, Detroit, Mich	do	990.80
1	Peppard & McKinney, Sault Ste. Marie, Mich	Vegetables, etc	*586.70
2	P. C. Keliher, Sault Ste. Marie, Mich	do	718.85
3	Prenzlauer Bros., Sault Ste. Marie, Mich	do	†456.13
4	Royce & Reynolds, Sault Ste. Marie, Mich	do	†504.53
5	Otto Supe & Co., Sault Ste. Marie, Mich	do	†540.25
1	Andrew Hotton, Sault Ste. Marie, Mich	Meats	*635.00
2	Donaldson & Hall, Sault Ste. Marie, Mich	do	*665.00
1	J. B. Sweatt, Sault Ste. Marie, Mich	Lumber	*120.00
2	E. D. Johnson, Sault Ste. Marie, Mich	do	150.00
3	Emery D. Weimer, Ludington, Mich	do	200.00
1	The Richmond & Backus Co., Detroit, Mich	Stationery	*391.31

* Recommended for acceptance. † Incomplete. No bid on milk.

REPORT OF LIEUT. CHARLES S. RICHÉ, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., July 4, 1894.

SIR: I have the honor to transmit the following report of operations of the survey of the Northern and Northwestern Lakes, resurvey of St. Marys River for the fiscal year ending June 30, 1894:

At the beginning of the fiscal year a small field observatory had been erected at Sault Ste. Marie, Mich., observations for latitudes had been completed, and observations for longitude were in progress. The triangulation had been planned from Whitefish Bay to about 10 miles north of Lake Huron. Ten triangulation stations had been erected. The "Soo" base had been measured and computed. A line of precise levels had been run from Sault Ste. Marie, Mich., to Waiska Bay and the computations nearly completed. A limited amount of hydrographic work had been done and considerable progress had been made toward fitting out field parties for subsequent work.

The allotment available for the fiscal year was $20,000, subsequently increased to $20,357.13. It was proposed to expend this amount in completing the essential astronomical work, in continuing the planning of the triangulation, in building stations, measuring angles, and in obtaining topography for the reach covered by chart No. 3 of the adopted series of new charts of the river. The hydrography it was proposed to take largely from the river and harbor surveys made and to be made in connection with the improvement of the river, such additional hydrography as might prove necessary for this chart being obtained by sounding through the ice during the winter. It was not proposed to duplicate recent Government surveys when doing so could be avoided.

The results accomplished during the fiscal year are as follows:

ASTRONOMICAL WORK.

Observatory.—The "Soo Observatory" which was used for this work was built during the coldest part of the winter of 1892-'93. It forms an ell of the U. S. Engineer Office at Sault Ste. Marie, Mich., and is shown in ground plan in the accompanying drawing. Being on Government land, it was made more substantial in structure than would otherwise have been the case, as it can remain permanently and will be a useful point for comparisons of longitude, etc., for future surveys of the Engineer Department. The observing piers are of masonry capped with a 24 by 24 inch block of cut stone, and have proved very stable. A small masonry pier supports a 12 by 12 inch timber to which the astronomical clock is bolted, and a small concrete pier for holding a dish of mercury to act as an artifical horizon in azimuth observations, etc., stands to the north of the west observing pier. The foundations of all these piers are independent of each other, and of the foundation of the building.

Latitude.—Observations for latitude were made on four nights, June 11, 14, 19, and 26, 1893. The manner of making them and their reduction is given in the report of Mr. Thomas Russell, appended, marked A, and attention is invited thereto for details. The resulting latitude of the east pier is 46° 30′ 06.25″ north, which, reduced to the west pier, gives 46° 30′ 03.27″ ±0.08″ as the latitude used in the reduction of the triangulation.

Longitude.—Observations for the difference of longitude between Sault Ste. Marie, Mich., and Ann Arbor, Mich., were made on ten nights, July 10, 15, 19, 20, and 26, and August 6, 7, 8, 9, and 12, 1893. On the first five nights Prof. Asaph Hall, jr., director of the Detroit Observatory at Ann Arbor, Mich., observed there, and I observed at the Soo Observatory. On the last five nights Prof. Hall observed at Sault Ste. Marie and I observed at Ann Arbor. The manner of making the observations and their reduction is also given in the report of Mr. Thomas Russell, appended, marked A, and attention is invited thereto for details.

At first considerable difficulty was experienced, owing mainly to trouble with the electro-magnets in the Ann Arbor Observatory. Fifty-ohm relays were used at the start, and while they worked satisfactorily at Sault Ste. Marie they did not do so at Ann Arbor, and had to be differently adjusted for receiving and sending signals. As it was desirable to avoid such changes in adjustment, more powerful relays were employed, with satisfactory results.

The scheme of wiring in the Soo Observatory is shown on the accompanying drawing. The operating switches there shown are for the purpose of passing almost instantly from the connections required for observing and talking to those for sending or receiving signals. The four "two-point" switches in each group were securely fastened side by side and their levers were connected by a bar in such manner that by pushing the bar all four switches would move simultaneously. The necessary changes could thus be made so rapidly that the deisred number of signals could be exchanged well within the short time generally available for the purpose, and the astronomical work could be conducted with more deliberation than would otherwise have been possible.

In this scheme of wiring the clock is kept on an independent 1-cell circuit, to avoid injury to its delicate break-circuit mechanism. The chronograph is also operated on a local circuit, in order that it may have a constant electric current through its magnet, to obviate as far as possible the necessity for changing the adjustment of the pen armature. An inspection of the drawing will show that when the 150-ohm signal relay is thrown out of this local circuit into the main line, the 150-ohm talking relay is thrown into the local in order to keep its current constant and avoid changes in adjustment of the chronograph pen armature. For this reason the two relays named should have practically the same electrical resistance, or else, by means of a rheostat, or otherwise, additional resistance should be put in the circuit where necessary to balance. A lightning arrester (not shown on drawing) is inserted in the main line where it enters the observatory.

The scheme of wiring at Ann Arbor was substantially similar to the above, with the addition that a rheostat and galvanometer were inserted in the main line, with

to keeping a constant current therein by plugging and unplugging resist- The fluctuations in strength of the main-line current were found so sudden gular in the length of line used, that more trouble was caused by trying to his arrangement than by leaving it alone. After the first few nights, therefore, ation was paid to this feature of the subject. With specially devised appa- or steadily altering its resistance, there is no doubt that the current in the ne can be kept practically constant and the galvanometer needle kept at a pointing in much the same manner as a boat is held on a fixed course, but I ery much if the accuracy of the work would be materially increased thereby. is work Assistant Engineer F. C. Shenehon acted as recorder at the Soo story and Mr. Elmer L. Allor at Ann Arbor. The services of both were highly tory. I am especially indebted to Inspector L. Fleming, who, without extra sation, performed the duties of telegraph operator at Sault Ste. Marie during gitude work, in addition to his regular duties in connection with the river bor work in this vicinity. Mr. Fleming also took charge of the chronograph ained first-class results from the old-style instrument that was used in this

eduction of the Ann Arbor work gives Soo Observatory (west pier) west of bor (Meridian Circle) 2 minutes 27.995 seconds ± 0.036 seconds. Taking the tainable value for the longitude of Ann Arbor, 5 hours 34 minutes 55.25 sec- est from Greenwich, gives Soo Observatory (west pier) west from Green- hours 37 minutes 23.25 seconds, or 84° 20′ 48.75″, which value was used eduction of the triangulation.

ptember, 1893, an attempt was made to determine the difference in longitude the Soo Observatory and the new Naval Observatory at Washington, Prof. ho was temporarily visiting Washington at the time, making the observa- ere. The observations were very incomplete, owing to cloudy weather, and square reduction of them was made.

anks are especially due to Prof. Asaph Hall, jr., for valuable suggestions and ce throughout all of the longitude work and also to the Western Union Tel- Company for granting us the use of their wires without charge.

th.—A triangulation station, known as △ azimuth, having been located in nearly north of the observatory for the purpose of forming a mark for the observations, it was determined to observe azimuth from the west pier servatory. These observations were delayed owing to repeated interference e mark by certain mischievous persons who resided near it. Two "light that had been erected at the station were removed and secreted. When the e was put in place, Mr. Joseph Cozens, Ontario land surveyor, very kindly his assistance, and put up a sign notifying the public that the box was an land survey mark and that he would prosecute any parties who disturbed ten days and nights thereafter the station was watched, but no further mis- s attempted. The Canadian authorities at Sault Ste. Marie, Ont., gave us sistance in their power, and it is sincerely trusted that the mark will not e disturbed.

bservations for azimuth were made on four nights, March 2, 8, 14, and 19, Assistant Engineer E. E. Haskell. The manner of making them, and their n, is also given in the report of Mr. Thomas Russell, appended, marked A, ention is invited thereto for details. The resulting azimuth of the line Soo tory (west pier) to △ azimuth is 178° 06′ 38.87″ from the south through the hich value was used in the reduction of the triangulation.

nuous latitude and azimuth.—For the purpose of obtaining additional data in to the recently-discovered movement of the pole, an effort will be made to latitude and azimuth continuously for a few years. A table of latitude stars very carefully prepared for this work, and a programme has been determined r the azimuth observations. Assistant Engineers Ripley and Dixon, who are d upon the river and harbor works in the vicinity, have volunteered for this ut so far have been too busy to accomplish very much. A short discussion subject, together with the adopted star lists, will be found in Mr. Russell's A). An effort will be made to have the places of these stars observed at one fixed observatories during the progress of the work.

PLANNING TRIANGULATION.

beginning of the fiscal year Assistant Engineer Fred Morley was engaged ing the triangulation. He continued this work until November 15, 1893, e left for Ann Arbor to resume his duties at the University of Michigan. his season's work Mr. Morley made a complete plan of the primary triangu- rom the old lake-survey line Michipicoten-Gargantua to the old lake survey nac Base." In addition, Mr. Morley planned a secondary system of triangu- or Whitefish and adjacent bays. Mr. Morley's final report of this work is d, marked B, and attention is invited thereto for details.

Mr. Morley's plan contained a large number of lines over 20 miles in length, the measurement of whose direction would have involved the extensive use of heliotropers. This would have made the angle-measuring expensive, as the experience we have already had with such lines has shown that they are liable to cause vexatious delays to the angle-measuring parties. I considered it advisable, therefore, to reduce the number of such lines as much as possible, and the large amount of information obtained by Mr. Morley rendered this a comparatively easy matter, involving but a small amount of additional reconnoitering.

Mr. Morley's connection with old station Gargantua was through Canadian territory back of △ Mamainse. This country is an absolute wilderness, and while Mr. Morley's plan of triangulation is doubtless the best that could be obtained through this back country, the measurement of the angles would be expensive, and it was thought best to see, by some additional reconnoitering, whether a cheaper connection could not be made with the old line Mamainse-Gargantua from some station on the Michigan shore of Lake Superior. A hill 260 feet above the lake was found at Crisps Point, Michigan, where, by erecting a high station, and by waiting until the refraction is excessive, △ Gargantua, 431 feet above the lake and about 60 miles distant, would be visible. All things considered this connection would be more economical than the other, in addition to giving better angles, and it has therefore been adopted. It is probable that Caribou Island Light-House can be located at little or no cost from the three stations shown on the drawing herewith, by reading the direction of the light from each of these stations at night when refraction is at its greatest. It is important to locate this island, as its location has never, to my knowledge, been accurately made.

The additional reconnoitering necessary for the modification of Mr. Morley's plan was done by Assistant Engineer E. E. Haskell in accordance with my instructions. Mr. Haskell's report on this work is appended, marked C, and attention is invited thereto for details.

Mr. Haskell also selected some secondary stations to connect the lower end of the river improvement tertiary triangulation with the primary system. These stations, together with the adopted plan of the primary triangulation, are shown on the drawing submitted herewith.

Although the number of lines requiring the use of heliotropes has been greatly reduced, some such lines still remain. These are mostly at the northern end of the work and are necessitated by the length of the old line Gargantua-Mamainse, to which connection must be made. It has been considered advisable to measure a base line on Batchewana Island, as the nearest bases to this end of the work, excepting the short Soo base, are at Keweenaw Point and the Straits of Mackinac. Batchewana Island being about halfway between the two, would make a very valuable point for a good base line. The Soo base would then serve as a check base for the work closer to the river; it is too short properly to control the long lines between the old stations of the lake survey at the east end of Lake Superior.

Mr. Morley's plan of secondary triangulation in Whitefish and adjacent bays involved the occupation with an instrument of each of a large number of secondary points. The primary points in this locality look down upon these bays in such manner that it would be possible to locate all necessary secondary points by intersection from at least three primaries, and with lines not exceeding 20 miles in length, without occupying any of the secondary points with an instrument. I can see no reason why this method should not give as accurate, and in many cases more accurate, results than the other, and the cost of locating the secondaries would be but little more than that for maintaining targets at each of them for the necessary length of time. These points could probably all be read in during the otherwise "dead time" that the angle-measuring parties were waiting for favorable conditions for reading the long primary lines that involved the use of heliotropes. In fact, I see no reason why this method of locating secondary points for hydrographers and topographers by intersection from a few primary stations should not generally be used more extensively than it appears to be. All secondary points on the resurvey of St. Marys River will be located in this manner as far as practicable.

BUILDING STATIONS.

Assistant Engineer Glen E. Balch was engaged in building stations at the beginning of the fiscal year, and continued this work until the middle of October, 1893, when it was stopped for the season. By this time 18 primary and 12 secondary stations had been erected and the necessary lines cut. Subsequently, Mr. Balch took charge of the erection of a higher station at South Gros Cap, which was needed to permit △ Larke to be seen therefrom. During the last few days of June, 1894, Mr. Balch was engaged in erecting △ Pennefather, one of the new stations required by the modified plan of triangulation. Mr. Balch's report is appended, marked D, and attention is invited thereto for details. The recent eight-hour law has increased the cost of this work to the Government.

MEASURING ANGLES.

ortly after the beginning of the fiscal year enough stations had been erected to it angle-measuring to begin and to proceed without interruption until the close season. This work was done by Assistant Engineer E. E. Haskell, whose report pended, marked E, and attention is invited thereto for details.

m July 5 to November 29, 1893, 11 stations were occupied; 20 measures each of 91 ary angles, and 8 measures each of 67 secondary angles were made. Especial tion is invited to the manner of measuring the primary angles, as outlined in Haskell's report. Each angle was measured separately. First, a pointing was on the left-hand target of a given angle, then on the right hand. Then a nting on the right hand and a repointing on the left hand. The instrument was double reversed, the left-hand target pointed at; then the right hand, repoint-nade on the right hand, and repointing made on the left-hand target. This was osition of the circle. Five such positions were taken of each angle, in five oximately equidistant parts of the limb of the instrument. While this gives measures of each angle than is customary in primary work, the results obtained an accuracy well within the required limit. The mean error inclosing the on was 1.04″, and in closing triangles was 1.43″.

is method, of course, requires an instrument with a very accurately graduated but there is no difficulty in obtaining such instruments at the present time. instrument used in this work was the old lake survey Troughton & Simms lolite No. 3, and was manufactured in 1876. It is an excellent instrument, but ones have undoubtedly been made since. No small share of the results obtained e to the angles having been read under favorable conditions, i. e., when the air steady and the seeing good. If the conditions were unfavorable, angle measur-vould be deferred until they improved. The phaseless targets used in this work ve especial attention; a complete description of them will be found in Mr. Has-s report (E).

this work a direct connection was made with the river improvement tertiary gulation at stations Iroquois and South Gros Cap, and the following tertiary ons were located by intersection from the primaries: Nos. 14 and 15 and old d Island light-house.

TOPOGRAPHICAL WORK.

order to obtain the requisite topography for chart No. 3 of the adopted series w charts of the river, it was decided to have two small topographical parties. he river improvement triangulation for the reach in question had not been ely completed, these parties had to start at the lower end of the reach (just east ult Ste. Marie, Mich., and Ontario), and work westward—this in order that they t make use of the completed triangulation at the start, although it obliged to work in the least accessible portion of their territory late in the season, n snow had begun to fall and communication was difficult.

vo plane tables were made for this work by Messrs. Buff & Berger, of Boston. ough capable of improvement they are excellent instruments and accomplished purpose satisfactorily. The region in question is not eminently suited to the e table on account of extensive timber and brush, and the difficulty of carrying a bulky instrument through the woods. An objection to the plane table, that ies everywhere, is that it can not be used during rainy or even moist weather— n the transit often can. It should, therefore, be used in connection with the sit or some similar instrument, and this was done by both topographical parties. great advantage of the plane table, however—an advantage likely to be under-nated—is, not only that it enables the work to be plotted in view of the ground r survey, but also that it obliges all transit and other work to be plotted at in the field, and plotted with great care, in order that the field plots can be as plane table sheets when favorable opportunities offer. This results in the turn-n of remarkably fine field sheets and the saving of much subsequent office work.

e noncompletion of the river triangulation until late in the season held back opographical work considerably, by preventing the issue of sheets with the tri-ilation points accurately projected thereon to scale. The preparation of such ts in advance would greatly facilitate and cheapen the topographical work, and expected that such sheets will be issued to these parties in the future for use as e table sheets and for plotting transit notes. It is expected that they will be rned at the close of the season in such condition as to enable the final reduction e chart to be made directly therefrom without any intermediate drafting work.

nerican shore.—The topography on this side of the river was obtained by Assist-Engineer H. von Schon, whose report is appended, marked F, and attention is ed thereto for details. An area of about 51.4 square miles was covered.

nadian shore.—The topography on this side of the river was obtained by Assist-

ant Engineer David Molitor, whose report is appended, marked G, and attention is invited thereto for details. An area of about 40 square miles was covered.

The average cost of these 91.4 square miles of topography was about $60 per square mile, and this gave a first-class topographical survey, showing all features of the ground, 20-foot contours, land survey lines, etc. By issuing projected sheets to the topographical parties in advance, as is proposed, and by somewhat altering the organization of the parties, it is confidently hoped that the cost of this work can be made as low as $45 per square mile without any loss of accuracy or detail. One reason for the higher cost of the work during the past season was that the two towns, Sault Ste. Marie, Mich., and Ontario, were included in the work, involving a great increase in detail. No more such work remains to be done, as these are the only towns of any consequence along the river.

It seems to me that $45 per square mile is about as low as a first-class topographical survey can be made for in territory like that adjacent to St. Marys River with the present instruments and methods. This cost, while fairly low in comparison with what work of this kind has cost in the past, is still sufficiently high to prohibit topographical work from being executed in many parts of the country where it is much needed. Some new method must be had which will very greatly reduce the cost of this class of work without diminishing its accuracy, and photography seems to be the only thing in sight that gives promise of accomplishing this result.

Photosurveying, or photogrammetry, is not new, but, hitherto, in this country, it has been very generally regarded as a fad. I have been in correspondence with some of the leading instrument makers of the United States, and have not found any that had ever manufactured any form of photosurveying apparatus. In accordance with my instructions Assistant Engineer H. von Schon has collected considerable information on this subject from European sources, and has found that in late years very considerable progress has been made there in this matter. An institute on phototopography has been in operation in Berlin for four years and is presided over by Prof. Meydenbaur; and all the leading European schools of technology have added this subject to their curriculum during recent years. Since 1870 phototopography has been an established and systematically practiced method in French, German, Austrian, and Italian government surveys, its use being confined chiefly to mountainous regions at first, but it has latterly been extended to coast, river, and interior operations as well; probaby the most elaborate survey now in progress with this method is the new survey of northern Italy, which is being executed with the plane-table and the phototheodolite. Even Canada has been engaged for the last three years on a survey of large extent in a mountainous district, using ten Troughton & Sims phototheodolites for the work. To show how backward English-speaking people have been on this subject, the literature on phototopography in the German, French, and Italian languages appears to be far more plentiful than that on topography in English.

The great trouble with photogrammetry has been the large amount of office drafting connected with it. This appears to be a very serious disadvantage, but if any improvement could be made which would render this office work cheaper and more expeditious the method would appear an ideal one for certain classes of work. It is, of course, impossible to tell, without actual experience, just what its limitations are, but in the triangulations of Whitefish Bay it would be possible for the assistant in charge of maintenance of targets, etc., who will have to visit each secondary point several times during the work, to obtain a series of photographs at each point at no cost other than that of the phototopographic instrument and plates. In this way I believe nearly all the shore of this bay could be surveyed at less cost than by any of the ordinary methods.

The chief varieties of phototopographic instruments appear to be the photogrammeter, the plane-table photogrammeter, and the phototheodolite. All of these instruments are regularly manufactured by the following instrument-makers: Otto Fennell, of Cassell, Germany; Ludwig Tesdorpf, of Stuttgart, Wurtemberg, Germany, and R. Lechner, Vienna, Austria. Other instrument-makers doubtless manufacture them, but their names and addresses have not yet been ascertained.

The extended use of this method in Europe would seem to indicate that it is of practical utility. Even with the excessive office drafting connected with it at the present time it would seem to be an excellent method in mountainous districts and possibly everywhere. It seems well suited to many localities along St. Marys River.

HYDROGRAPHY.

In connection with the operations of improving the ship channel 20 and 21 feet in depth between Chicago, Duluth, and Buffalo, a hydrographic survey of a large portion of the river adjacent to the localities where improvements are in progress or are contemplated, has been begun. This survey will cover the reaches of the river shown on charts 2 and 3 of the adopted series of new charts. As this work, like

er and harbor" surveys, will be done with great care and accuracy, the will not duplicate it, and the soundings obtained will be used for the

. will mostly be done through the ice during the winter, the sounding bored with the recently invented ice auger, a description of which will pp. 2963, 2964 of the Annual Report of the Chief of Engineers for 1893. plan of the survey is to sound a series of cross sections at right angles ig lines and 500 feet apart. These cross sections to be carried to 1,000 h side of the sailing line, every other cross section to be extended to close thereto as the thickness of the ice will permit. Soundings on each en every 50 or 100 feet apart. At critical points in the river more minute being made in connection with the execution of each contract for deep-annel.

ie past winter an area of about 13 square miles was surveyed through is manner, but the ice was poor during the winter and broke up early, the completion of as much work as had been contemplated. During the ber it is intended to put more parties at this work, with the view to finish- the ice lasts.

OFFICE WORK.

close of field operations at the end of the season of 1893 an adjustment gulation was made, as follows: The station adjustments were made, then angles thus obtained, giving each the same weight, and thereafter neg- her station conditions, an adjustment was made by the best quadrilateral inable from the network of measured angles. In this adjustment check the quadrilateral system used were neglected. Although this adjust- ot a rigid one, the character of the angle measuring was such that the ined in this way could differ but little from those that would have been a rigid adjustment, and the latter would have required from two to is' more time to make, and when made would have given results no tically, than those obtained by the method used.

ne this adjustment was completed, the astronomical reductions were l work was begun computing the geodetic coordinates of the various he primary work. These coordinates were also computed for the river t tertiary triangulation stations that had been connected with the pri- 1.

tion of the astronomical work will be found in the report of Mr. Thomas ended, marked A. The reduction of the triangulation will be found in askell's report, appended, marked E, and attention is invited thereto The reduction of the line of precise levels, run from Sault Ste. Marie, aiska Bay, was completed, and Mr. Haskell's report thereon will be found narked H.

ble work was also done in getting the topography in proper shape for the time the various field sheets had been completed, the geodetic coor- he stations in the reach covered by chart No. 3 were ready, and work naking projections of the topography on a scale of 1 to 10,000 for the use sman in reducing the chart for the engraver. These sheets will also record sheets of the survey. Another season, if sheets with the triangu- ted thereon can be issued in advance to the topographical parties, this of drafting work can probably be avoided. A detailed statement of the ie in the office will be found in the report of Assistant Engraver H. von nded, marked F.

PROPOSED WORK.

already done will enable chart No. 3 of the new series to be issued ie next allotment will be expended in extending the triangulation, and, in obtaining enough information to permit the publication of chart No. l require the topographical and hydrographical work to be carried down m Sault Ste. Marie. It would be very desirable to have some accurate servations made during the progress of the survey, and it is thought 1 be done at small cost. Everything is now in readiness to push the work e necessary funds become available.

CONTRACTS, EXPENDITURES, ETC.

The following contracts have been in force during the fiscal year:

Contractor.	For—	Date.	Remarks.
P. M. Church & Co	Ship chandlery and hardware	Apr. 27, 1893	Closed Dec. 31, 1893.
Prenzlauer Bros	Groceries	....do	Do.
Andrew Hotton	Meats	....do	Do.

On March 8, 1894, proposals were invited for stationery, ship chandlery and hardware, lumber, meats and ice, groceries, and vegetables. The bids received were publicly opened on March 28, 1894, but contracts have not yet been awarded. The following articles of engineer property have been received during the fiscal year, viz: 1 Buff & Berger railroad transit, No. 245; 3 stadia rods for same; 2 binocular field glasses; 2 Buff & Berger plane tables, complete; 1 telescope, monocular (lake survey, No. 7) (since lost by burning of tug *Mystic*); 4 heliotropes; 2 tripods for same.

The following statement shows the expenditures during the fiscal year and the work to which they pertain:

Allotted	$20,357.43
Expended:	
Astronomical work	726.32
Planning triangulation	2,808.35
Building stations	4,344.14
Measuring angles	2,793.13
Topography	6,166.09
Office work	3,442.54
Contingencies	71.94
Outstanding liabilities	4.92
Total	20,357.43

ESTIMATE.

For the continuation of work on the resurvey of St. Marys River $40,000 can be profitably expended during the fiscal year ending June 30, 1896. This is for field work and office computations alone, and does not include the final drafting of charts, nor does it include other work of like character elsewhere on the lakes. If this amount were appropriated to be available until expended, as is done for other work under the Engineer Department, a great saving both in time and money could be effected for the Government, and work would not have to stop in the best part of the season, as is now often the case. This method of appropriation has worked so well in the river and harbor work of the Corps of Engineers that it would seem very desirable to have it applied generally to all surveys made by the Engineer Department.

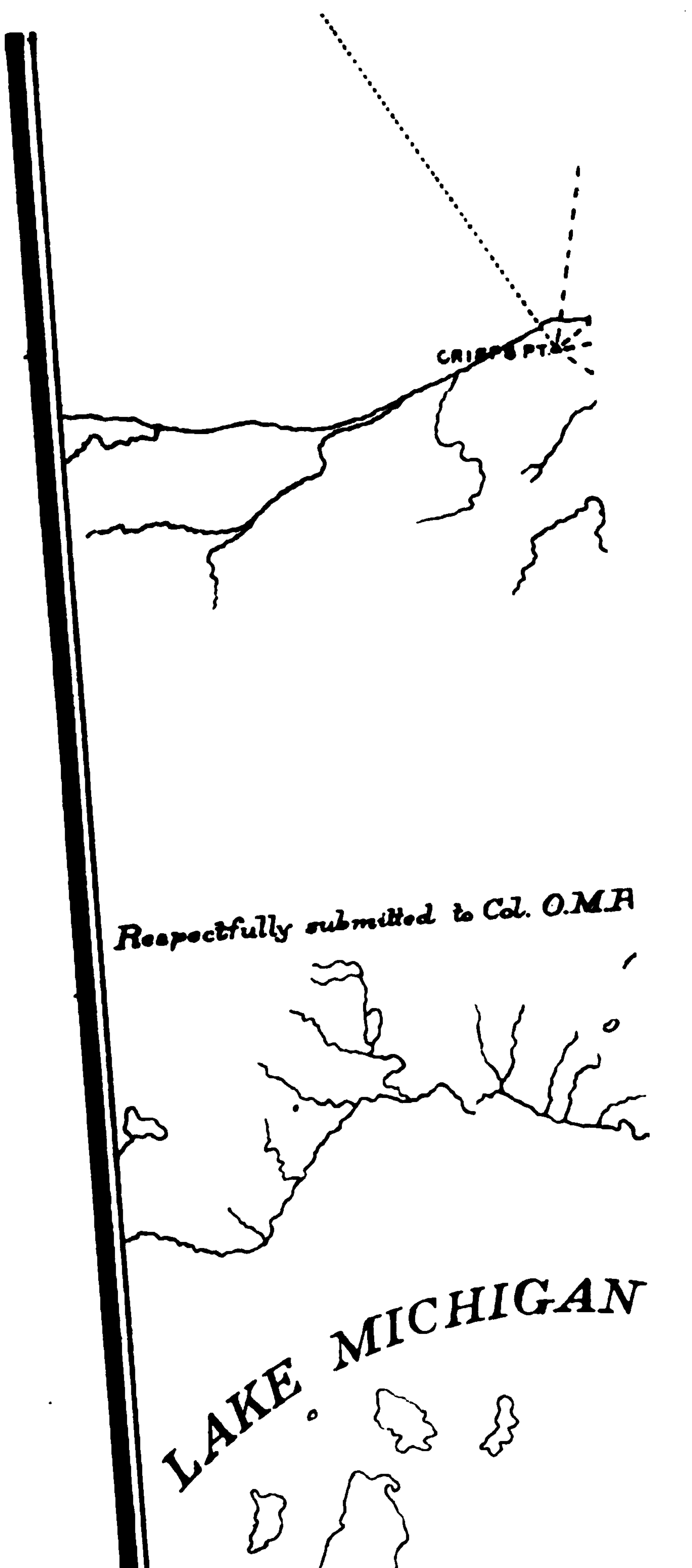
The work done during the past fiscal year has shown that very considerable natural and artificial changes have taken place in St. Marys River and its shores during the forty years that have elapsed since the original survey was made. The importance of the river to navigation has increased over a hundredfold during this time. Where 100,000 tons of freight passed through the river in 1855, over 10,000,000 tons passed in 1893. The vessels carrying this freight have greatly increased in size and cost; the narrow channels of the river are frequently crowded with them, and accidents are by no means rare. Surely such commerce as this is deserving of all the aid possible. The amount of the estimate ($40,000) is small in comparison to the advantages which would result to this commerce by the early publication of new charts showing the channels to be run and the dangers to be avoided in the difficult navigation of this portion of the greatest commercial waterway of the world.

In conclusion, I desire to express my appreciation of the services rendered by all employed on the survey during the fiscal year, and particularly by Messrs. Morley, Haskell, Russell, Von Schon, Molitor, and Balch, who have been in the charge of the various portions of the work. I must again express my appreciation of the many courtesies received from the engineers and others employed upon river and harbor works in this vicinity, and must again acknowledge my indebtedness to Assistant Engineer E. S. Wheeler for valuable suggestions and advice.

Very respectfully, your obedient servant,

CHARLES S. RICHÉ,
First Lieut., Corps of Engineers, U. S. Army.

Col. O. M. POE,
Corps of Engineers, U. S. Army.


CRISPS PT.
Respectfully submitted to Col. O.M.P
LAKE MICHIGAN

A.—REPORT OF MR. THOMAS RUSSELL.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., June 30, 1894.

[have the honor to make the following report on the reduction of the observa- r latitude made at Sault Ste. Marie, Mich., and for the difference of longitude ı Sault Ste. Marie and Ann Arbor, Mich., and for azimuth at the observatory, ;e. Marie.

vations for latitude were made by First Lieut. Charles S. Riché. The tions for longitude were made by First Lieut. Charles S. Riché at Sault Ste. ,nd Prof. Asaph Hall, jr., at Ann Arbor on the first five nights. The observers :changed stations, Prof. Hall observing at Sault Ste. Marie and Lieut. t Ann Arbor on the second five nights. The observations for azimuth were r Mr. E. E. Haskell, U. S. assistant engineer, on four nights.

LATITUDE.

bservations for latitude were made by the Talcott method with zenith tele- Vürdemann No. 12. The instrument was mounted on the east stone pier of e Survey Observatory. The focal length of the telescope is 32 inches, diam-)bject glass 2⅝ inches, and magnifying power 42.

bservations were made June 11, 14, 19, and 26, 1893, Mr. F. C. Shenehon, sistant engineer, acting as recorder. On the first night 24 pairs of stars were 1, 25 on the second and third nights, and 26 on the fourth.

alue of one division of the level used was 1 division equals 1 minute. The ' 1 revolution of micrometer used was 1 revolution equals 63.483″ as deter- rom the observations on Polaris at eastern elongation May 20 and 21.

pparent declinations of the stars were taken, where possible, from the Ber- tronomisches Jahrbuch list of 622 stars for 1893. For stars not in Berlin ·h the places were obtained from the Northern Boundary survey catalogue of s or the Safford catalogue of 2,018 stars. The day places were obtained by ng the mean places for 1893 from the places for 1875 given in the catalogues, lying to them the reductions obtained from the sums of the products Aa', and Dd', with an allowance for the proper motion of the star when appre- The factors a', b', c', d' used, were not those given in the Safford catalogue, ones computed with the mean right ascensions and declinations for 1893.

tar places for the nights of June 11, 19, and 26 were computed by means of ors; the places for June 14 were obtained by interpolation from the 11th and

ars in Safford's catalogue are designated by letters according to the accuracy ich the star's declination is known. They are:

	Seconds.
e error of declination for star of class AA	0.18
e error of declination for star of class A	.28
e error of declination for star of class B	.43
e error of declination for star of class C	.7

ars of the Berlin Jahrbuch and Northern Boundary Survey catalogue were ed to have the places as well known as stars of class AA.

er to obtain the best value for the latitude in taking the means of the results ıer weight must be given to the various pairs of stars depending on the accu- th which the star places are known. Suppose a pair has been observed on n ; nights. Then if e is the probable error of a single half difference of zenith s of the stars and e_1 and e_2 the probable errors of their declinations, respec- he weight of the mean of the results from this pair will be proportional to: *

$$\frac{1}{\frac{(e_1^2+e_2^2)}{4}+\frac{e^2}{n}}$$

e for e was found by the process of comparing the individual results from of stars with their mean. From the work of four nights the value of e was $\pm 0.70''$,† from the formula $e=0.67\sqrt{\frac{[vv]}{(n-m)}}$ in which $[vv]$ is the sum of res of the residuals, m the total number of pairs observed, and n the number nt pairs.

* R. S. Woodward, U. S. Geological Survey Bulletin, No. 49.

† Chauvenet's Astronomy, Vol. II, p. 351.

The table of weights adopted is as follows:

Number of nights pair is observed.	Weights for combinations of classes.					
	A A and A A.	A A and A.	A A and B.	A and A.	A and B.	B and B.
1........	0.98	0.96	0.93	0.93	0.90	0.88
2........	1.89	1.80	1.60	1.72	1.63	1.54
3........	2.72	2.53	2.34	2.40	2.21	2.05
4........	3.51	3.23	2.90	2.99	2.70	2.47

The details of the work for latitude are given in the following table. The firs column gives the date of the observation. The second column gives the star num ber and the letter A or B, which is its class designation in the Safford catalogue the letters N. B. indicate Northern Boundary survey catalogue; the letters B. J. indi cate the star place is taken from the Berlin Jahrbuch. The third and fourth column give the star's declination for the dates of observation. The fifth column gives th half sum of the declinations for each pair. The sixth and seventh columns give th micrometer and level measurements, which together make up the half difference o zenith distances of the pairs of stars observed. The eighth column gives the cor rection for refraction, the ninth column the result for latitude, and the tenth colum the weight of the mean.

Details of latitude work, Sault Ste. Marie, Mich.

Date	Star and class designation		δ_1	δ_2	$\frac{1}{2}(\delta_1+\delta_2)$	$\frac{1}{2}(Z_1-Z_2)$. Micrometer.	$\frac{1}{2}(Z_1-Z_2)$. Level	Correction for refraction	ϕ Latitude.	Weight.
1893			° ′ ″	° ′ ″	° ′ ″	′ ″	″	″	° ′ ″	
June 11	ι Draco, B J	232 A	65 15 12 57	28 00 58.65	46 38 05.61	− 6 02 22	+4.32	−0 15	46 30 07.56	0.96
June 11	κ Bootis, B. J	α Draco, B. J	27 54 10.43	64 53 19.46	46 23 44.92	+6 13.06	+7.45	+0 12	05.55	
14			10.86	19.89	45.38	+6 20.49	+0.43	+0.12	06.42	
								Mean	46 30 05.06	1 89
June 11	271 B	θ Bootis, B. J	40 14 26.77	52 20 45.06	46 17 35.92	+12 18.24	+11.73	+0 21	06.10	
14			27.20	46 64	36.42	+12 28.81	+0.02	+0.21	05.46	
								Mean	46 30 05.78	1 69
June 11	309 A.	320 A	65 51 48.76	26 58 54.59	46 25 21.68	+4 44.25	−1 23	+0.09	04 79	
14			49.26	55.00	22.13	+4 44.68	−0 70	+0 09	06.40	
19			50 09	55.69	22.89	+4 42.06	+0.58	+0.09	06.54	
								Mean	46 30 06 01	2 40
June 11	327 B	342 A	42 49 51.10	50 03 56.85	46 26 53.96	+3 12.19	−0.55	+0.05	05.67	
14			51 61	57.61	54.61	+3 10.32	+0.32	+0.05	05.30	
								Mean	46 30 05 48	1 63
June 11	361 A	363 A	66 20 06.16	26 42 34.43	46 31 20.30	−1 13.04	−1.98	0.02	05.26	
14			06.76	34.89	20 82	−1 16.02	−0.40	−0.02	04.38	
19			07 76	35.65	21.70	−1 10.27	+0 60	−0 02	06.01	
26			09.31	36.99	23 15	−1 15.24	+0 85	−0.02	05 74	
								Mean	46 30 05.35	2.09
June 11	386 A.	ι Draco, B. J	33 18 55.67	59 20 26.56	46 19 41.12	+10 25.28	−0.62	+0 18	05.96	
14			56.21	27.34	41.78	+10 25.09	+0.08	+0 18	07.13	
19			57.11	28.56	42.84	+10 23.28	+0.76	+0.18	07 05	
26			58.60	30 07	44.34	+10 21.34	+0.85	+0 18	06.71	
								Mean	46 30 06.71	3 29
June 14	405 A	θ Cor., Bor B J	61 02 20.94	31 43 08.52	46 22 44.73	+7 21.46	+0.02	+0.13	06.34	
19			22.06	09.45	45.76	+7 20.13	+0.63	+0 13	06 65	
26			23.80	10.97	47 38	+7 17.83	+1 00	+0 13	06.26	
								Mean	46 30 06.42	2 55

Details of latitude work, Sault Ste. Marie, Mich.—Continued.

Date.	Star and class designation.		δ_1	δ_2	$\frac{1}{2}(\delta_1+\delta_2)$.	$\frac{1}{2}(Z_1-Z_2)$. Micrometer.	$\frac{1}{2}(Z_1-Z_2)$. Level.	Correction for refraction.	ϕ Latitude.	Weight.
			° ′ ″	° ′ ″	° ′ ″	″	″	″	° ′ ″	
1893.										
June 11	ϕ Bootis. B. J.	444 A	40 42 02.27	32 41 51.58	46 41 56.92	11 40.57	—0.05	—0.20	10.10	
14			02.90	52.27	57.58	—11 50.44	—0.10	—0.20	06.84	
19			03.96	53.44	58.70	—11 54.69	+2.30	—0.20	06.11	
26			05.63	55.25	42 00.44	—11 55.33	+1.68	—0.20	06.59	
								Mean ..	46 30 07.41	3.23
June 11	470 A	476 A	38 15 16.20	55 03 03.37	46 39 09.78	—9 05.35	+0.50	—0.16	46 30 04.77	
14			16.83	04.11	10.47	—9 03.10	+0.50	—0.16	07.71	
19			17.94	05.36	11.65	—9 06.62	+1.00	—0.16	05.87	
26			19.67	07.27	13.47	—9 07.64	+1.20	—0.16	06.87	
								Mean ...	46 30 06.31	2.09
June 11	479 A	θ Drac. B. J	33 37 28.04	58 51 00.45	46 14 14.24	+15 47.33	—0.48	[1]+0.28	01.58	
14			28.67	01.30	14.98	+15 50.40	—0.40	+0.28	05.26	
19			29.72	02.67	16.20	+15 48.47	+1.03	+0.28	05.98	
26			31.80	04.43	18.12	+15 47.30	+0.58	[2]+0.28	06.49	
								Mean ...	46 30 04.83	3.23
June 11	500 B	506 A	58 12 54.80	34 07 41.54	46 10 18.17	+19 48.47	—1.39	+0.35	05.69	
14			55.56	42.32	18.94	+19 49.39	—1.40	+0.35	07.28	
19			56.89	43.27	20.08	+19 47.23	+0.43	+0.35	08.09	
26			58.88	45.02	21.98	+19 44.88	+0.73	+0.35	07.94	
								Mean ...	46 30 07.25	2.70
June 11	516 A	524 A	60 00 46.49	32 34 51.55	46 17 49.02	+12 16.59	—0.83	+0.22	05.00	
14			47.28	52.21	49.74	+12 15.13	0.00	+0.22	05.09	
19			48.61	53.30	50.96	+12 15.04	+0.50	+0.22	06.72	
26			50.66	54.74	52.70	+12 12.53	+0.78	+0.22	06.23	
								Mean ...	46 30 05.76	2.09
June 14	η Drac. B. J.	277 N. B	61 45 18.75	30 43 17.86	46 14 18.30	+15 50.69	—1.65	+0.20	07.03	
19			20.17	18.06	19.56	+15 44.98	+1.13	+0.29	05.96	
26			22.08	20.67	21.38	+15 44.25	+0.38	+0.29	06.30	
								Mean ...	46 30 06.63	2.72

June 11	500 A	Gr. 2377 B. J	36	42	20.24 [1]	50	58	16.50	[2] 46	50	22.92	−20	17.36	+1.73	[3] 0.35			06.95	
14					29.97			17.50			23.74	−20	19.70	+0.40	0.35			04.40	
19					31.10			18.07			25.08	−20	21.57	+2.38	−0.35			05.54	
26					33.11			20.95			27.03	−20	22.08	+1.58	−0.35			06.18	
															Mean ..	46	30	05.77	3.23
June 11	585 B	597 B	46	10	03.33	46	42	37.14	46	26	20.24	+3	47.24	−0.20	+0.06			07.34	
14					04.14			37.06			21.05	+3	46.06	−0.48	+0.06			06.69	
19					05.50 [1]			39.34			22.42	+3	42.51	+1.38	+0.06			06.32	
26					07.60			41.47			24.54	+3	41.05	+1.73	+0.06			07.38	
															Mean	46	30	06.93	2.47
June 11	609 A	625 A	56	50	36.61	36	04	19.09	46	27	27.85	+2	43.56	−5.00	+0.05	46	30	06.46	
14					37.40			19.85			28.67	+2	38.42	+0.03	+0.05			07.11	
19					38.97			21.12			30.04	+2	34.90	+1.65	+0.05			06.73	
26					41.22			23.14			32.18	+2	33.76	+1.20	+0.05			07.19	
															Mean .	46	30	06.87	2.93
June 11	297 N. B.	π Herc. B. J	55	54	07.27	36	55	38.43	46	24	52.85	+5	12.27	−0.75	+0.09			04.46	
14					08.10			39.27			53.72	+5	11.90	+0.45	+0.09			06.22	
19					09.65			40.67			55.16	+5	10.53	+1.28	+0.09			07.06	
26					11.93			42.57			57.25	+5	07.19	+1.48	+0.09			06.01	
															Mean ..	46	30	03.94	3.51
June 11	643 A	ν^1 Drac. B. J	37	24	04.11	55	15	17.44	46	10	40.78	+10	24.26	−0.36	+0.18			04.84	
14					04.91			18.45			41.68	+10	24.90	−0.53	+0.18			06.13	
19					06.23			20.01			43.12	+10	22.48	+0.78	+0.18			06.50	
26					08.20			22.35			45.32	+10	19.40	+1.93	+0.18			06.83	
															Mean .	46	30	06.09	3.23
June 14	659 A	ν^2 Drac. B. J	37	14	31.43	55	14	36.97	46	14	34.20	+15	32.60	−0.85	+0.27			06.22	
19					32.77			38.53			35.65	+15	29.61	+0.38	+0.27			05.91	
26					34.85			40.87			37.86	+15	27.07	+0.35	+0.27			05.55	
															Mean	46	30	05.89	2.55
June 19	687 A	689 A	61	57	15.75	31	15	25.25	46	36	20.50	−6	13.98	+0.95	−0.16			07.31	
26					18.17			27.24			22.70	−6	16.01	+0.60	−0.16			07.13	
															Mean ..	46	30	07.22	1.72
June 11	o Herc. B. J.	36 Drac. B. J	28	44	42.20	64	21	27.62	46	33	04.96	−2	56.99	−0.40	−0.06			05.51	
14					43.10			28.70			06.90	−2	59.91	+0.68	−0.06			06.61	
19					44.47			30.37			07.42	−3	02.04	+0.95	−0.06			06.27	
26					46.80			32.85			09.58	−3	03.06	+0.96	−0.06			07.42	
															Mean .	46	30	06.46	3.51

[1] Reduction to meridian +0.21″.

[2] Reduction to meridian +0.12″.

[3] Reduction to meridian +0.37″.

Details of latitude work, Sault Ste. Marie, Mich.—Continued.

Date.	Star and class designation.		δ_1	δ_2	$\frac{1}{2}(\delta_1+\delta_2)$.	$\frac{1}{2}(Z_1-Z_2)$. Micrometer.	$\frac{1}{2}(Z_1-Z_2)$. Level.	Correction for refraction.	ϕ Latitude.	Weight.
1893.			° ′ ″	° ′ ″	° ′ ″	° ″	″	″	° ′ ″	
June 11	766 A	784 A	68 42 50.08	23 47 32.42	46 15 11.25	+14 54.95	−0.75	+0.30	05.75	
14			51.03	33.15	12.09	+14 52.98	−0.23	+0.30	05.14	
19			52.71	34.86	13.54	+14 52.19	+0.00	+0.30	06.63	
26			55.22	36.25	15.74	+14 48.86	+0.45	+0.30	05.85	
								Mean ...	46 30 05.72	2.99
June 11	ε Lyrae B. J.	829 A	39 33 18.41	52 52 01.41	46 12 39.91	+17 27.37	−0.88	+0.30	46 30 06.70	
14			19.40	02.39	40.90	+17 25.25	+0.75	+0.30	07.20	
19			20.92	04.02	42.47	+17 23.72	+0.68	+0.30	07.17	
26			23.16	06.49	44.82	+17 22.07	−0.08	+0.30	06.51	
								Mean ...	46 30 06.90	3.23
June 11	β Lyrae B. J.	θ Drac. B. J	33 14 08.34	59 15 14.45	46 14 41.40	+15 23.30	−1.35	[1] +0.27	03.95	
14			09.21	15.46	42.34	+15 21.27	+0.55	[2] +0.27	04.90	
19			10.67	17.18	43.92	+15 20.63	+0.88	[2] +0.27	06.17	
26			12.70	19.56	46.13	+15 20.50	−0.08	[2] +0.27	06.43	
								Mean ...	46 30 05.36	3.51
June 11	ε Lyrae B. J.	895 A	35 55 45.60	56 40 22.56	46 18 04.08	+12 02.31	−0.43	+0.21	06.17	
14			46.58	23.54	05.06	+12 01.83	−0.05	+0.21	07.05	
19			48.07	25.20	06.64	+11 58.21	+1.10	+0.21	06.10	
26			50.25	27.71	08.98	+11 57.93	−0.08	+0.21	07.04	
								Mean ...	46 30 06.60	3.23
June 11	δ Drac. B. J.	919 A	67 28 09.63	26 03 15.56	46 45 42.60	−15 35.10	−0.25	−0.30	06.95	
14			10.62	16.26	43.44	−15 30.25	−0.03	−0.30	06.80	
19			12.28	17.44	44.85	−15 41.01	+1.05	−0.30	04.59	
26			14.72	19.21	46.96	−15 40.09	+0.90	−0.30	07.47	
								Mean ...	46 30 06.47	3.23
June 11	955 A.	957 A	34 13 20.32	58 21 53.72	46 17 37.02	+12 28.12	−0.65	+0.22	04.71	
14			21.20	54.71	37.96	+12 25.93	+0.98	+0.22	05.09	
19			22.66	56.35	39.52	+12 25.42	+0.63	+0.22	06.79	
26			24.85	58.85	41.85	+12 23.89	+0.70	+0.22	06.66	
								Mean ...	46 30 05.56	2.99

June 19	970 A.	977 A	63	11	34.18	29	54	15.72	46	32	51.95	−2	52.83	+3.48	−0.05	05.55	
26					36.60			17.83			57.26	−2	52.48	+2.43	−0.05	07.16	
															Mean ...	46 30 06.36	1.72
June 26	1072 A.	1097 A	64	31	05.74	28	22	07.96	46	26	36.85	+3	29.62	+0.68	+0.07	46 30 07.22	0.93
26	1115 A.	1154 A	47	22	58.62	45	33	46.40	46	28	22.51	+1	44.02	+0.40	+0.03	46 30 07.56	0.93
Weighted mean																46 30 06.25	±0.08

[1] Reduction to meridian +0.33″. [2] Reduction to meridian +0.47″. [3] Reduction to meridian +0.21″.

The means of the pairs for latitude on the different nights are as follows:

	°	′	″
June 11, 24 pairs	46	30	05.74
14, 26 pairs	.		06.19
19, 25 pairs			06.35
26, 26 pairs			06.71

The weighted mean of the 101 pairs observed gives for the latitude of the east pier, Sault Ste. Marie Observatory, 46° 30′ 06″.25. The reduction to the west stone pier, on which the transit instrument is mounted and for which the longitude has been determined, is + 0″.02.

The adopted result for latitude of the west stone pier of the Sault Ste. Marie Observatory, the origin of coordinates of the resurvey of the Saint Marys River is therefore 46° 30′ 06″.27 ± 0″.08.

LONGITUDE.

The difference of longitude between Sault Ste. Marie, Mich., and Ann Arbor, Mich., was determined telegraphically from observations made on 10 nights—on the nights of July 10, 15, 19, 20, and 26, and, after exchange of observers, on August 6, 7, 8, 9, 10, and 12.

The instrument used at Sault Ste. Marie during the observations was the Würdemann Transit No. 1. The focal length of telescope is about 31 inches, the clear aperture of the object glass 2½ inches, and the magnifying power about 65 diameters. The transit was mounted on the west stone pier of the observatory. The foot screws rested on slotted brass plates, securely fastened to the stone pier by hydraulic cement.

The instrument is provided with a reticule of seven wires. The values of the wire intervals determined from all the observations of the time work for longitude are as given below. Separate values were derived for each observer.

Equatorial wire intervals.

[Würdeman Transit No. 1.]

REDUCTION TO MEAN OF THE WIRES.

[Clamp east.]

Wire.	Observer, Lieut. Riché.	Observer, Prof. Hall.
	s.	*s.*
I	13.814	13.827
II	8.849	8.830
III	4.654	4.639
IV	—0.180	0.178
V	—4.673	—4.637
VI	—8.888	—8.874
VII	—13.601	—13.614

The value of one division of the striding level is 1″.00. The mean of all the observations made for inequality of pivots showed it to be inappreciable and the inequality adopted was zero.

At Sault Ste. Marie, sidereal clock, Wm. Bond & Sons, No. 256, was used with break-circuit attachment by T. S. & J. D. Negus, and the electric-motor chronograph, Wm. Bond & Sons, No. 316, run by 6 cells of gravity battery. In observations for time the mean of 7 wires was used on time stars, and for slow stars 3 wires before reversal and 4 after.

At Ann Arbor the instrument used in determining time was the Pistor and Martins meridian circle of the Detroit Observatory at Ann Arbor. The focal length is 97 inches. The diameter of the object glass is 6¼ inches. The magnifying power used was 180. The distance between the wyes is 40.2 inches. The pivot of the west end of axis is greater in diameter by 0.00011 inches than the pivot on the east end, which corresponds to a correction of —0ˢ.025 to be applied to the level readings. The pivots are very accurately circular, as determined with a spherometer caliper. The value of one division of the hanging level is 1 div. =0ˢ.0538. The observations of hanging level were not used in the final reduction of the time work, but used merely as a control to indicate any change of level.

The value of one revolution of the micrometer screw is 1ˢ.3710, as determined from the interval between wires B_1 and B_4.

The wire intervals of the meridian circle for the direct position of the instrument, which was the one used throughout all the observations for time, are as follows, as determined from all the observations made for time. Separate values were derived for each observer.

Equatorial wire intervals.

[Pistor and Martin's meridian circle of the Detroit Observatory, at Ann Arbor, Mich.]

REDUCTION TO THE MEAN OF THE WIRES.

[Telescope direct.]

Wires.	Observer, Lieut. Riché.	Observer, Prof. Hall.
	s.	*s.*
A1	42.884	42.863
A2	39.944	39.919
A3	34.161	34.165
B1	14.161	14.171
B2	5.618	5.598
B3	−0.118	−0.110
B4	−5.809	−5.796
B5	−14.399	−14.377
C1	−33.981	−33.997
C2	−39.737	−39.739
C3	−42.733	−42.677

On time stars the mean of 11 wires was used; on slow stars, a variable number of wires on different nights.

The collimation of wire B_3 was determined by observations on the collimators north and south of the instrument. Usually three determinations of the collimation were made each night—one at the beginning, one at the middle, and one at the end of the time work. This value being for wire B_3, it is reduced to what it would be for the mean of the wires by the value of the wire interval.

The level and collimation combined were determined by nadir observations of wire B_3 and the reflected image over Mercury. Three determinations of this also were made each night.

The difference of the two determinations, that is, the collimation alone from the collimators and the level and collimation combined as determined from the nadir observations, gives a value of the level. The observations of the slow stars directly over part of the wires and reflected from Mercury over part, give another value of the level. The means of the two values of level thus obtained were used in the time reductions, interpolated values being taken according to the time of observation of the various time stars.

The level determined in this way includes the inequality of pivots, so that there is no correction to be specially made to the values on account of the inequality.

The time piece used at Ann Arbor was a Lukens sidereal chronometer, No. 141, with a Negus break circuit and a Fauth chronograph.

The order of observations at Sault Ste. Marie was as follows: A slow star was observed over 3 wires, then telescope reversed and the star observed when possible over 4 wires; the striding level was read before and after reversal. Then 6 time stars were observed over 7 wires and the instrument reversed; the level was observed before and after the reversal. Then 6 more stars were observed, then another slow star over 3 wires, and the instrument reversed and 4 wires observed after reversal. A level was taken before and after the reversal.

After the second slow star, signals were exchanged with Ann Arbor. The clock was put on the main line twice for at least 2 minutes each time, breaking the circuit automatically, the seconds of the Sault Ste. Marie clock being recorded on the Ann Arbor chronograph and the seconds of the Ann Arbor chronometer on the Sault Ste. Marie chronograph, the zero seconds of each minute being skipped. Two sets of arbitrary signals were sent from each place extending over 2 minutes, the signals being recorded on the chronograph at both places. The signals were about 2 seconds apart and were made by the observer or telegraph operator breaking the circuit with the observing key.

After exchanging signals observations of stars were made as before signals, beginning with a slow star and a reversal on it, then observing 6 time stars and reversing and observing 6 more time stars and ending with the observation of a slow star and reversal on it. The observations extended over 4 hours and 25 minutes.

At Ann Arbor the same stars were observed each night as at Sault Ste. Marie. The instrument, however, was not reversed during the period over which the observations for longitude extended.

On the first two nights, July 10 and 15, the star programme used was different from that used on the subsequent nights.

The right ascensions used in the reductions were taken from the Berlin Jahrbuch.

The two lists of stars used, their declinations, and the star factors *A. B. C.*, for the two places Sault Ste. Marie and Ann Arbor, are given in the following table:

Star lists and star factors for longitude work.

[Sault Ste. Marie latitude, 46° 30′ 06″.27; Ann Arbor latitude, 42° 16′ 48″.]

FIRST LIST.

Star.	Declination. °	′	″	Sault Ste. Marie. A	Sault Ste. Marie. B	Sault Ste. Marie. C	Ann Arbor. A	Ann Arbor. B
β Urs. Min	74	35	41	−1.77	3.32	3.76	−2.01	[illegible]
β Libræ	−8	59		0.83	0.57	1.02	0.79	[illegible]
γ^2 Urs. Min	72	13		−1.43	2.96	3.28	−1.63	[illegible]
ν^1 Bootis	41	12		0.12	1.32	1.33	0.02	[illegible]
γ Libræ	−14	26		0.91	0.50	1.04	0.86	[illegible]
α Serpentis	6	46		0.64	0.78	1.01	0.58	[illegible]
μ Serpentis	−3	06		0.76	0.65	1.00	0.71	[illegible]
β^1 Scorpii	−19	31		0.97	0.43	1.06	0.94	[illegible]
δ Ophiuchi	−3	25		0.77	0.64	1.00	0.72	[illegible]
Herculis	46	34		0.00	1.46	1.46	−0.11	[illegible]
β Herculis	21	43		0.45	0.98	1.08	0.38	[illegible]
σ Herculis	42	39		0.10	1.35	1.36	−0.01	[illegible]
η Herculis	39	08		0.16	1.28	1.29	−0.07	[illegible]
ε Urs. Min	82	12	47	−4.31	5.99	7.38	−4.74	[illegible]
δ Urs. Min	86	36	42	−10.90	12.94	16.02	−11.82	[illegible]
109 Herculis	21	43		0.46	0.98	1.08	0.38	[illegible]
χ Draconis	72	41		−1.49	3.02	3.37	−1.70	[illegible]
α Lyræ	38	41		0.18	1.28	1.29	0.08	[illegible]
110 Herculis	20	27		0.47	0.96	1.07	0.40	[illegible]
R Lyræ	43	48		0.07	1.39	1.39	−0.04	[illegible]
λ Aquilæ	−5	03		0.79	0.63	1.01	0.74	[illegible]
δ Aquilæ	2	54		0.69	0.73	1.01	0.64	[illegible]
ι Cygni	51	30		−0.14	1.60	1.61	−0.26	[illegible]
θ Cygni	49	58		−0.09	1.55	1.56	−0.21	[illegible]
δ Cygni	44	52		−0.04	1.41	1.41	−0.06	[illegible]
α Aquilæ	8	35		0.63	0.80	1.02	0.56	[illegible]
β Aquilæ	6	08		0.65	0.77	1.01	0.50	[illegible]
χ Cephei	77	23	13	−2.35	3.93	4.58	−2.63	[illegible]

SECOND LIST.

Star.	Declination. °	′	″	Sault Ste. Marie. A	Sault Ste. Marie. B	Sault Ste. Marie. C	Ann Arbor. A	Ann Arbor. B
ε Urs. Min	82	12	47	−4.31	5.99	7.38	−4.740	[illegible]
η Ophiuchi	15	36		0.91	0.49	1.04	0.879	[illegible]
π Herculis	36	56		0.20	1.23	1.25	0.117	[illegible]
β Draconis	52	23		−0.17	1.64	1.64	−0.287	[illegible]
ξ Serpentis	−15	20		0.91	0.40	1.04	0.876	[illegible]
ι Herculis	46	04		0.00	1.44	1.44	−0.095	[illegible]
μ Herculis	27	47		0.37	1.07	1.13	0.283	[illegible]
γ Draconis	51	30		−0.14	1.60	1.61	−0.257	[illegible]
72 Ophiuchi	9	33		0.61	0.81	1.02	0.548	[illegible]
μ Sagittarii	21	05		0.90	0.42	1.07	0.958	[illegible]
η Serpentis	2	56		0.77	0.66	1.01	0.711	0.71
χ Draconis	72	41		−1.40	3.02	3.37	−1.700	[illegible]
α Lyræ	38	41		0.18	1.28	1.20	0.080	[illegible]
51 H. Cephei L. C.	87	12	51	+14.87	−14.22	−20.58	+15.880	[illegible]
λ Urs. Min	88	58	23	−37.65	41.13	55.77	−40.580	[illegible]
β Aquilæ	6	08		0.65	0.77	1.01	0.593	[illegible]
θ Aquilæ	−1	08		0.74	0.68	1.00	0.688	[illegible]
o^1 Seq. Cygni	46	25		0.00	1.45	1.44	0.105	[illegible]
α^2 Capricoi	−12	53		0.89	0.52	1.03	0.842	[illegible]
γ Cygni	39	55		0.15	1.30	1.31	0.054	[illegible]
θ Cephei	62	38		−0.60	2.09	2.18	−0.756	[illegible]
α Cygni	44	54		0.03	1.41	1.41	−0.064	[illegible]
η Cephei	61	25		−0.51	2.02	2.10	−0.680	[illegible]
32 Vulpeculæ	27	30		0.37	1.06	1.12	0.286	[illegible]
ν Cygni	40	45		0.13	1.31	1.32	0.035	[illegible]
ν Aquarii	−11	48		0.87	0.53	1.03	0.827	[illegible]
α Equulei	4	48		0.67	0.75	1.01	0.610	[illegible]
1 H. Draco L. C.	81	48	01	+5.50	−4.36	−7.01	+5.810	[illegible]

Reduction.—The formula used for the reduction of observations with the transit instrument in the meridian to determine the time is:

$\alpha = t + \Delta t + Aa + Bb + C\,(c + ab'n)$.

α = the right ascension of the star.

t = the observed time of star, the mean of 7 or 11 wires.

Δt = the clock correction.

a = the instrumental azimuth, minus when the deviation is west of south, plus when east of south.

b = the instrumental level, minus when the east end of the pivot axis is high, plus when the west end is high.

c = the instrumental collimation, minus when the mean of the wires is west of the optical axis and plus when east.

$ab'n$ = diurnal aberration = $-0^s.021 \cos.\ \varphi \sec.\ \delta$.

A = the azimuth factor dependent on the position of star = $\sin.\ (\varphi - \delta) \sec.\ \delta$.

B = the level factor dependent on the position of the star = $\cos.\ (\varphi - \delta) \sec.\ \delta$.

C = the collimation factor dependent on the position of star = $\sec.\ \delta$.

δ = the declination of the star.

φ = the latitude of the place.

In the reduction of the Sault Ste. Marie observations the collimation was first derived from the observation of the slow stars. The observation of each wire was reduced to the mean of the wires by multiplying the equatorial interval by the secant of the declination of the star and adding it to the observed time. The difference between the mean of the wires observed with the telescope in the two positions before and after reversal gives twice the collimation, which divided by the factor C for the star gives the instrumental collimation c.

The slow stars give four values for the collimation each night.

The observed times were corrected for collimation, aberration, and level, and from the corrected times was derived by the method of least squares the most probable value of the clock correction, the clock rate during the time of observation, and the instrumental azimuth.

The form of the observation equation for the reduction by least squares is:

$$Aa + R\rho + \Delta t_0 + (t'\,\alpha -) = v.$$

R = the interval in hours between the time of observation of the star and the epoch or instant to which the clock correction Δt_0 applies, which is taken as the mean of the times of all the stars.

ρ = the hourly rate of the clock, plus when losing, minus when gaining.

A = the azimuth factor of the star.

a = the instrumental azimuth.

Δt_0 = the clock correction at the epoch, minus when fast, plus when slow.

t' = the observed time of the star corrected for collimation, aberration, and level.

v = the residual due to unavoidable error of observation.

Where there is more than one azimuth used during the night the azimuths are indicated by a' a'', etc.

Each observation equation was weighted according to the number of wires over which the star was observed and the accuracy with which its transit can be determined. A fast moving star can be observed more accurately than a slow one.

The weight unity was given to a star observed at Sault Ste. Marie over 7 wires and for which the declination is less than 45°. For a star observed at Ann Arbor the weight unity was given to 11 wires for declinations less than 45°.

The formula for the weight used in the case of incomplete transits less than 7 or 11 wires is:

$$p = \frac{E_1^2 + \dfrac{E^2}{N}}{E_1^2 + \dfrac{E^2}{n}}$$

p = the weight.

E_1 = the probable error of culmination reduced to the equator.

E = the probable error of transit over a single thread.

N = the number of wires to which the weight unity is assigned, 7 or 11.

n = the number of wires actually observed.

The value adopted for E_1 is $\pm 0^s.049$. The value of E for Würdemann Transit No. 1 is taken as $\pm 0^s.080$. From this follows the weights used for various numbers of wires.

Würdemann Transit No. 1.

Number of wires observed.	p.
4	0.82
5	.90
6	.95
7	1.00

For the instrument at Ann Arbor the weights derived by a similar formula were adopted as given by the Coast Survey for large portable transits (report for 1880, Appendix No. 14, p. 39).

Pistor and Martin's meridian circle, Detroit Observatory at Ann Arbor, Mich.

Number of wires observed.	p.	Number of wires observed.	p.
1	0.44	7	0.93
2	.64	8	.96
3	.75	9	.97
4	.82	10	.99
5	.87	11	1.00
6	.90		

The weights for stars dependent on the declination are taken as inversely proportional to the squares of the probable errors of transit over a single thread, the weight for a transit at the equator being taken as unity. The formula according to which the probable error ε increases with the declination δ is:

$$\varepsilon = \left\{ (0.06)^2 + (0.049)^2 \sec.^2 \delta \right\}^{\frac{1}{2}}$$

as given in the Coast Survey report.

The tables 1 to 40 following contain the details of the observations on the various nights. There are two tables for each night's work. In the first table the first column gives the name of the star; where the letters L. C. occur it indicates the star was observed at lower culmination, that is, below the pole. The second column gives the position of telescope, clamp east or west; the third gives the number of wires observed; the fourth the instrumental level; the fifth the correction for level; the sixth the correction for collimation and aberration; the seventh the correction for azimuth; the eighth the correction for rate; the ninth the mean of the wires observed; the tenth the right ascension; the eleventh the clock correction; the twelfth the residual, the computed minus the observed, multiplied by the square root of the weight. The second table for each night gives the observation equations, there being one equation for each star observed. The first term of the equation is the azimuth, the second the rate, the third the clock correction, and the last the numerical term. The second side of the equation is the residual, which is the unavoidable error of observation.

In the time observations at Sault Ste. Marie the azimuth of the transit instrument did not usually remain constant during the night. The reductions were made with two or more azimuths where the observations showed an undoubted change. On July 10 two azimuths were used, the least square reduction giving the azimuths $a = -1^s.876$ for the first half of the night and $a' = -2^s.663$ for the second half; July 15 one azimuth was sufficient $a = -2^s.139$; July 19 two azimuths were derived $a = -1^s.083$, and $a' = -1^s.497$; July 20 one azimuth was used $a = -2^s.034$; July 26 four azimuths were derived $a = +0^s.183$, $a' = -0^s.077$, $a'' = -0^s.647$, and $a''' = -0^s.958$; August 6 there are two azimuths $a = -0^s.746$, $a' = -1^s.062$; August 7 one azimuth $a = -0^s.701$; August 8 one azimuth $a = -0^s.823$; August 9 one azimuth $a = -0^s.596$; August 12 three azimuths $a = -0^s.288$, $a' = -0^s.579$, $a'' = -0^s.896$.

In the Ann Arbor time determinations a single value for the azimuth was used for each night in all the reductions. The large change of azimuth between the nights of July 20 and July 26 from $a = +0^s.023$ to $a = -0^s.822$ is due to adjustment of the instrument. The azimuths being large necessitated using the azimuth factors A in the observation equations to three places of decimals.

In the observation equations, for Δt_0 is substituted a number of whole seconds plus $\delta\Theta$ the fractional part of the second, in order to have the numbers small in multiplying and forming the normal equations.

Table 41 gives a résumé of the determinations for collimation for each instrument.

Table 42 gives a résumé of the results of observations for time.

Table 43 contains the details of comparisons of clock at Sault Ste. Marie and chronometer at Ann Arbor. For each night's work 6 sets of signals each way were taken, usually 15 signals in a set. Three sets of the signals were taken from the automatic clock signals and three sets from the arbitrary signals made by hand. On the nights of July 26 and August 8 the clock and chronometer beats were so nearly coincident that exact estimates of the times could not be made.

Table 44 contains a résumé of the results of the exchange of signals for difference of longitude.

TABLE 1.—*Time determination, Sault Ste. Marie, Mich., July 10, 1893.*

[First Lieut. Charles S. Riché, observer.]

Star.	Cl.	Number of wires.	b.	Bb.	C. (c. − abn.).	Ac.	Rρ.	Clock time of transit = t.	Right ascension = α.	Clock correction = Δt.	$\sqrt{p}\,v$ (co. − ob.).
			s.	*s.*	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*
β Urs. Min	W	3	−0.10	−0.32	−1.65	−3.32	−0.36	14 50 52.3	14 51 04.63	+11.3	+0.38
β Urs. Min	E	3	+0.07	+0.23	−1.55	+3.32	−0.36	14 50 48.6	....	......	......
β Libræ	E	7	+0.04	+0.02	+0.34	−1.57	−0.31	15 10 06.20	15 11 16.83	+12.15	+0.04
γ² Urs. Min	E	7	+0.01	+0.04	+1.10	+2.66	−0.29	15 20 41.78	15 20 57.56	+12.27	−0.04
ν¹ Bootis	E	7	0.00	0.00	−0.44	−0.23	−0.28	15 26 55.22	15 27 07.33	+12.18	+0.01
γ Libræ	E	7	0.00	0.00	+0.35	−1.69	−0.27	15 29 23.86	15 29 34.49	+12.24	−0.05
α Serpentis	E	7	−0.02	−0.02	+0.34	−1.21	−0.25	15 38 50.85	15 39 01.86	+12.15	+0.04
μ Serpentis	E	7	−0.04	−0.02	+0.33	−1.43	−0.24	15 43 53.80	15 44 04.18	+11.74	+0.45
β¹ Scorpii	W	7	−0.08	−0.04	−0.38	−1.82	−0.21	15 59 05.17	15 59 15.12	+12.40	−0.21
δ Ophiuchi	W	7	−0.09	−0.06	−0.36	−1.44	−0.18	16 08 36.15	16 08 46.44	+12.33	−0.14
τ Herculis	W	7	−0.10	−0.15	−0.53	0.00	−0.17	16 16 22.09	16 16 33.76	+12.52	−0.20
β Herculis	W	7	−0.11	−0.11	−0.39	−0.85	−0.14	16 25 28.37	16 25 39.37	+12.49	−0.30
σ Herculis	W	7	−0.12	−0.17	−0.49	−0.17	−0.13	16 30 30.16	16 30 41.58	+12.38	−0.19
η Herculis	W	7	−0.13	−0.17	−0.47	−0.31	−0.12	16 38 04.62	16 39 16.04	+12.49	−0.30
ε Urs. Min	W	3	−0.17	−1.03	−2.61	−8.09	−0.08	16 56 45.1	16 57 03.28	+13.8	−0.40
ε Urs. Min	E	3	−0.02	−0.15	+2.40	−8.09	−0.08	16 56 39.3	....	......	......
δ Urs. Min	E	3	−0.04	−0.50	+5.71	+29.03	+0.06	18 06 18.9	18 07 03.24	+10.0	+0.22
δ Urs. Min	W	4	−0.08	−1.07	−6.19	+29.03	+0.08	18 06 31.4	....	......	......
109 Herculis	W	7	−0.10	−0.10	−0.39	−1.20	+0.11	18 19 00.10	18 19 10.72	+12.20	−0.01
χ Draconis	W	7	−0.11	−0.34	−1.22	+3.95	+0.12	18 22 48.97	18 23 02.95	+11.47	+0.35
α Lyræ	W	7	−0.14	−0.18	−0.47	−0.46	+0.14	18 33 09.97	18 33 21.41	+12.41	−0.22
110 Herculis	W	7	−0.16	−0.15	−0.39	−1.25	+0.16	18 40 55.34	18 41 05.81	+12.10	+0.09
R Lyræ	W	7	−0.19	−0.26	−0.50	−0.17	+0.18	18 51 55.77	18 52 07.22	+12.20	−0.01
λ Aquilæ	W	7	−0.21	−0.13	−0.37	−2.09	+0.20	19 00 26.74	19 00 36.84	+12.49	−0.30
δ Aquilæ	E	7	−0.06	−0.05	+0.34	−1.84	+0.24	19 19 58.05	19 20 08.74	+12.00	+0.19
ι Cygni	E	7	−0.07	−0.12	+0.54	−0.37	+0.26	19 26 49.48	19 27 03.05	+12.52	−0.27
θ Cygni	E	7	−0.08	−0.12	+0.52	+0.25	+0.27	19 33 24.06	19 33 36.81	+11.83	+0.30
δ Cygni	E	7	−0.09	−0.12	+0.47	−0.11	+0.29	19 41 27.49	19 41 40.28	+12.26	−0.07
α Aquilæ	E	7	−0.09	−0.07	+0.34	−1.65	+0.30	19 45 25.31	19 45 36.24	+12.01	+0.18
β Aquilæ	E	7	−0.10	−0.07	−0.34	−1.73	+0.31	19 49 53.28	19 50 05.91	+11.78	+0.41
χ Cephei	E	3	−0.10	−0.41	+1.19	+6.26	+0.36	20 12 15.0	20 12 33.04	+10.6	+0.58
χ Cephei	W	3	+0.01	+0.05	−1.31	+6.26	+0.36	20 12 17.1	....	......	......

Clock correction at 17.5 hours: Clock time, + 12.194; hourly rate, + 0.134

Collimation = c, clamp E.

	s.
β Urs. Min	+0.426
ε Urs. Min	+0.339
δ Urs. Min	+0.352
χ Cephei	+0.273
Mean	+0.348

Azimuth .... $\begin{cases} -1.876 \\ -2.663 \end{cases}$

TABLE 2.—*Observation equations, Sault Ste. Marie, Mich., July 10, 1893.*

[Epoch, 17.5 hours, clock time. $\Delta t = +12.00 + \delta\theta$.]

$$
\begin{array}{ll}
-1.77a - 2.66\rho + \delta\theta - 2.30 = v \overset{p}{0.18} & -10.90a' + 0.60\rho + \delta\theta - 27.12 = v \overset{p}{0.011} \\
 & \\
+0.834a - 2.33\rho + \delta\theta + 1.73 = \quad 1 & +0.451a' + 0.81\rho + \delta\theta + 0.89 = \quad 1 \\
-1.420a - 2.18\rho + \delta\theta - 2.64 = \quad 0.24 & -1.483a' + 0.87\rho + \delta\theta - 3.54 = \quad 0.23 \\
+0.123a - 2.06\rho + \delta\theta + 0.33 = \quad 1 & +0.174a' + 1.04\rho + \delta\theta - 0.09 = \quad 1 \\
+0.903a - 2.02\rho + \delta\theta + 1.72 = \quad 1 & +0.469a' + 1.17\rho + \delta\theta + 0.90 = \quad 1 \\
+0.644a - 1.86\rho + \delta\theta + 1.31 = \quad 1 & +0.065a' + 1.36\rho + \delta\theta - 0.21 = \quad 1 \\
+0.763a - 1.78\rho + \delta\theta + 1.93 = \quad 1 & +0.786a' + 1.50\rho + \delta\theta + 1.40 = \quad 1 \\
 & \\
+0.969a - 1.53\rho + \delta\theta + 1.63 = \quad 1 & +0.691a' + 1.82\rho + \delta\theta + 1.60 = \quad 1 \\
+0.766a - 1.36\rho + \delta\theta + 1.29 = \quad 1 & -0.140a' + 1.94\rho + \delta\theta - 1.15 = \quad 0.67 \\
-0.002a - 1.24\rho + \delta\theta - 0.35 = \quad 0.74 & -0.094a' + 2.05\rho + \delta\theta - 0.35 = \quad 0.69 \\
+0.451a - 1.08\rho + \delta\theta + 0.50 = \quad 1 & +0.040a' + 2.18\rho + \delta\theta - 0.44 = \quad 1 \\
+0.091a - 1.00\rho + \delta\theta - 0.08 = \quad 1 & +0.622a' + 2.25\rho + \delta\theta + 1.34 = \quad 1 \\
+0.165a - 0.86\rho + \delta\theta - 0.06 = \quad 1 & +0.657a' + 2.32\rho + \delta\theta + 1.64 = \quad 1 \\
 & \\
-4.31a - 0.56\rho + \delta\theta - 9.77 = \quad 0.06 & -2.35a' + 2.70\rho + \delta\theta - 5.23 = \quad 0.13
\end{array}
$$

Normal equations.

$$
\begin{array}{rrrrr}
[+6.46]a & & -8.08\,\rho & +4.79\,\delta\theta & +12.28 = 0 \\
 & [+4.93]a' & +5.91\,\rho & +3.02\,\delta\theta & +11.75 = 0 \\
-8.08a & +5.91a' & +[63.30]\,\rho & -0.11\,\delta\theta & -7.92 = 0 \\
+4.79a & +3.02a' & -0.11\,\rho & +[21.95]\,\delta\theta & +12.73 = 0
\end{array}
$$

Results.

$$
\begin{aligned}
& \qquad\quad s. \\
\delta\theta &= +0.194 \\
\rho &= +0.134 \\
a' &= -2.663 \\
a &= -1.876
\end{aligned}
$$

TABLE 5.—*Time determination, Sault Ste. Marie, Mich., July 15, 1888.*

[First Lieut. Charles S. Riche, observer.]

Star	Cl.	Number of wires	b	Bb	C. (c.—sin.)	Aa	Kp	Clock time of transit—t.	Right ascension—α.	Clock correction ΔT.	v (res.—ob.)
			s.	s.	s.	s.	s.	h. m. s.	h. m. s.	s.	
β Urs. Min	E	3	0.00	—0.01	+0.40	—3.79	—0.06	14 50 48.2	14 51 04.27	10.9	+0.33
β Urs. Min	W	3	—0.11	—0.37	—0.50	—3.79	—0.06	14 50 56.5	....	......	......
β Libræ	W	7	—0.12	—0.07	—0.25	—1.78	—0.05	15 11 07.08	15 11 18.79	+11.26	—0.03
γ Urs. Min	W	7	—0.14	—0.42	—0.50	3.04	—0.05	15 20 44.00	15 20 57.26	+11.40	—0.08
ι Bootis	W	7	—0.15	—0.30	—0.32	—0.26	—0.04	15 27 48.97	15 27 07.35	+11.08	+0.17
γ Libræ	W	7	—0.15	—0.07	—0.25	—1.93	—0.04	15 29 23.71	15 29 34.46	+11.04	+0.19
ε Serpentis	W	7	—0.16	—0.12	—0.25	—1.38	—0.04	15 38 52.25	15 39 01.63	+11.37	—0.14
μ Serpentis	W	7	—0.17	—0.11	—0.24	—1.62	—0.04	15 43 54.87	15 44 04.15	+11.20	+0.02
β Scorpii	E	7	+0.01	+0.01	+0.23	—2.07	—0.03	15 59 05.67	15 59 15.10	+11.09	+0.14
δ Ophiuchi	E	7	0.00	0.00	0.22	—1.64	—0.03	16 08 36.64	16 08 46.42	11.22	0.00
τ Herculis	E	7	+0.01	—0.02	+0.32	0.00	—0.03	16 16 22.37	16 16 33.65	11.04	+0.16
β Herculis	E	7	—0.02	—0.02	+0.23	—0.97	—0.02	16 25 28.63	16 25 38.34	+11.49	—0.28
σ Herculis	E	7	—0.03	0.04	+0.29	—0.19	—0.02	16 30 29.76	16 30 41.31	11.71	—0.49
η Herculis	E	7	—0.04	—0.05	+0.28	—0.35	—0.02	16 39 04.55	16 39 15.98	11.57	—0.36
ε Urs. Min	E	3	—0.05	—0.29	2.30	9.22	—0.01	16 58 40.4	16 57 02.70	11.1	+0.09
ε Urs. Min	W	4	0.00	—0.01	2.50	—9.22	—0.01	16 56 44.9	....	......	......
δ Urs. Min	W	3	+0.06	1.03	4.03	—23.33	—0.01	18 06 31.3	18 07 01.96	+12.3	—0.11
δ Urs. Min	E	4	—0.08	+1.03	—5.56	+23.33	—0.01	18 06 19.7	......	......	......
109 Herculis	E	7	—0.06	0.07	+0.23	—0.97	—0.02	18 19 00.06	18 19 10.73	11.32	—0.09
χ Draconis	E	7	—0.07	—0.22	—0.73	+3.17	0.02	18 22 47.73	18 23 02.83	10.98	+0.13
α Lyræ	E	7	+0.07	+0.09	+0.78	0.37	0.02	18 33 09.79	18 33 21.41	11.09	0.22
110 Herculis	E	7	0.08	0.07	0.23	+1.00	+0.03	18 40 55.20	18 41 05.83	+11.30	—0.07
R Lyræ	E	7	+0.06	—0.08	—0.30	—0.14	+0.03	18 51 55.74	18 52 07.22	11.22	+0.01
λ Aquilæ	E	7	+0.06	0.03	0.22	—1.68	+0.03	19 00 27.17	19 00 36.80	11.12	+0.11
ι Aquilæ	W	7	0.04	+0.03	—0.25	—1.48	+0.04	19 19 50.33	19 20 08.79	11.12	+0.11
Cygni	W	7	+0.02	0.03	—0.39	+0.30	+0.04	19 26 52.17	19 27 03.07	+10.92	+0.28
θ Cygni	W	7	0.00	0.00	—0.38	+0.20	+0.04	19 33 26.19	19 33 36.83	+10.80	0.36
δ Cygni	W	7	+0.02	0.02	—0.34	—0.09	+0.05	19 41 29.52	19 41 40.32	+11.16	+0.07
α Aquilæ	W	7	+0.02	+0.02	—0.25	—1.33	0.05	19 45 26.45	19 45 36.30	+11.36	—0.13
β Aquilæ	W	7	—0.03	0.03	—0.25	—1.39	+0.05	19 49 56.49	19 50 05.97	11.04	0.19
χ Cephei	W	3	+0.04	—0.17	—0.66	+5.03	+0.06	20 12 18.6	20 12 33.07	+10.2	+0.33
χ Cephei	E	2	—0.12	—0.45	0.54	5.03	0.06	20 12 17.6	......	......	......

Clock correction at 17.5 hours. Clock time, 11.232 hourly rate, 0.022.

Collimation=c, clamp C.

	s.
β Urs. Min	+0.120
ε Urs. Min	+0.325
δ Urs. Min	0.343
χ Cephei	0.131
Mean	+0.230
Azimuth	—2.139

TABLE 4.—*Observation equations, Sault Ste. Marie, Mich., July 15, 1893.*

[Epoch, 17.5 hours, clock time. $\Delta t - 11.00 + \delta\theta$.]

	p		p
$-1.77\,a - 2.66\rho + \delta\theta - 3.66 = v$	0.18	$-10.90\,a + 0.60\rho + \delta\theta - 24.7 = v$	0.011
$+0.834a - 2.33\rho + \delta\theta + 1.57 =$	1	$+0.451a + 0.81\rho + \delta\theta + 0.63 =$	1
$-1.420a - 2.18\rho + \delta\theta - 3.39 =$	0.24	$-1.483a + 0.87\rho + \delta\theta - 3.15 =$	0.23
$+0.123a - 2.06\rho + \delta\theta + 0.24 =$	1	$+0.174a + 1.04\rho + \delta\theta - 0.25 =$	1
$+0.903a - 2.02\rho + \delta\theta + 1.93 =$	1	$+0.469a + 1.17\rho + \delta\theta + 0.67 =$	1
$+0.644a - 1.86\rho + \delta\theta + 1.05 =$	1	$+0.065a + 1.36\rho + \delta\theta - 0.11 =$	1
$+0.763a - 1.78\rho + \delta\theta + 1.47 =$	1	$+0.786a + 1.50\rho + \delta\theta + 1.53 =$	1
$+0.969a - 1.53\rho + \delta\theta + 2.01 =$	1	$+0.691a + 1.82\rho + \delta\theta + 1.32 =$	1
$+0.766a - 1.36\rho + \delta\theta + 1.44 =$	1	$-0.140a + 1.94\rho + \delta\theta - 0.26 =$	0.67
$-0.002a - 1.24\rho + \delta\theta - 0.01 =$	0.74	$-0.094a + 2.05\rho + \delta\theta - 0.04 =$	0.69
$+0.451a - 1.08\rho + \delta\theta + 0.50 =$	1	$+0.040a + 2.18\rho + \delta\theta - 0.12 =$	1
$+0.091a - 1.00\rho + \delta\theta - 0.50 =$	1	$+0.622a + 2.25\rho + \delta\theta + 0.92 =$	1
$+0.165a - 0.86\rho + \delta\theta - 0.20 =$	1	$+0.651a + 2.32\rho + \delta\theta + 1.30 =$	1
$-4.31\,a - 0.56\rho + \delta\theta - 9.30 =$	0.06	$-2.35\,a + 2.70\rho + \delta\theta - 4.34 =$	0.13

Normal equations.

$$[+11.39]a - 2.17\rho + 7.81\,\delta\theta + 22.60 = 0$$
$$-2.17\,a\ [+63.30]\rho - 0.11\,\delta\theta - 5.99 = 0$$
$$+7.81\,a - 0.11\rho\ [+21.95]\,\delta\theta + 11.61 = 0$$

Results.

$$\begin{aligned} & \quad\ \ s. \\ \delta\theta &= +0.232 \\ \rho &= +0.022 \\ a &= -2.139 \end{aligned}$$

TABLE 5.—*Time determination, Sault Ste. Marie, Mich., July 19, 1893.*

[First Lieut Charles S Riché, observer.]

Star.	Cl.	Number of wires	b.	Bb	C. (c. abn.).	Aa	Rp.	Clock time of transit =t.	Right ascension=α.	Clock correction Δt.	$v\sqrt{p}$ (co.—ob.).
			s.	s.	s.	s.	s.	h. m. s.	h. m. s.	s.	s.
ε Urs. Min	W	3	-0.04	-0.24	— 3.31	+ 4.07	—0.09	16 50 52.0	16 57 02.19	+ 0.1	+0.23
ε Urs. Min	E	4	+0.02	+0.14	+ 3.10	4.67	—0.09	16 56 45.3	... .	...	....
η Ophiuchi	E	7	+0.01	+0.01	+ 0.34	— 0.99	-0.08	17 04 07.82	17 04 16.69	+ 9.78	+0.24
π Herculis	E	7	-0.00	—0.01	+ 0.41	0.23	—0.08	17 11 11.22	17 11 21.52	+10.21	—0.19
β Draconis	E	7	—0.04	0.07	+ 0.54	- 0.18	—0.07	17 27 53.18	17 28 03.43	+ 9.67	+0.28
ξ Serpentis	E	6	-0.05	—0.03	+ 0.34	— 0.99	-0.06	17 31 20.97	17 31 30.18	+ 9.95	+0.07
ι Herculis	E	7	-0.07	-0.10	+ 0.48	0.01	—0.06	17 36 18.52	17 36 29.13	+10.28	—0.15
μ Herculis	E	7	—0.09	-0.00	+ 0.37	— 0.39	—0.06	17 42 08.67	17 42 18.61	+10.15	—0.13
γ Draconis	W	7	—0.10	-0.16	0.56	+ 0.15	—0.05	17 54 00.42	17 54 09.81	+10.03	-0.01
72 Ophiuchi	W	7	—0.10	-0.08	0.37	— 0.66	—0.04	18 02 00.98	18 02 19.04	+10.21	—0.19
μ Sagittarii	W	7	-0.10	—0.04	0.38	— 1.07	-0.04	18 07 16.13	18 07 21.72	10.12	-0.10
η Serpentis	W	7	-0.11	—0.07	— 0.36	0.82	-0.04	18 15 40.13	18 15 48.92	+10.08	-0.06
χ Draconis	W	7	-0.11	0.33	- 1.21	+ 1.60	—0.03	18 22 52.37	18 23 02.70	+10.30	—0.14
α Lyræ	W	7	—0.11	-0.14	- 0.46	— 0.19	—0.02	18 33 12.40	18 33 21.40	+ 9.81	+0.21
51 H. Cephei L. C.	W	3	-0.11	+1.00	+ 6.84	—10.14	—0.01	18 50 05.1	6 50 05.20	+ 7.8	+0.18
51 H. Cephei L. C.	E	4	+0.03	-0.47	- 6.26	—10.14	—0.01	18 50 20.3	....	......	......
λ Urs. Min	E	4	—0.03	3.58	+18.50	+56.36	+0.01	19 29 34.8	19 30 52.40	+ 6.4	+0.11
λ Urs. Min	W	3	-0.05	-2.18	—20.07	+56.36	+0.01	19 30 11.9	....	......	.....
β Aquilæ	W	7	—0.06	-0.04	— 0.36	— 0.83	+0.03	19 49 57.34	19 50 06.01	+ 9.67	+0.15
θ Aquilæ	W	7	—0.07	-0.05	— 0.36	— 1.11	+0.04	20 05 41.08	20 05 49.68	+10.08	—0.08
o¹ Seq. Cygni	W	7	-0.08	0.11	— 0.52	0.00	+0.04	20 10 08.92	20 10 18.19	+ 9.86	+0.14
α² Capricor.	W	7	-0.08	-0.04	— 0.37	— 1.32	+0.04	20 12 01.47	20 12 00.93	+10.15	—0.13
γ Cygni....	W	7	-0.09	—0.11	- 0.47	— 0.22	+0.04	20 18 16.42	20 18 25.71	+10.05	—0.05
ξ Cephei	W	7	—0.10	-0.21	— 0.78	+ 0.00	+0.05	20 27 39.76	20 27 49.81	+10.09	—0.06
α Cygni	E	7	-0.08	—0.11	+0.47	— 0.06	+0.06	20 37 38.87	20 37 49.44	+10.21	—0.19
η Cephei	E	7	—0.09	0.18	+0.69	+ 0.81	+0.06	20 42 58.27	20 43 09.36	+ 9.71	+0.22
32 Vulpec	E	7	-0.10	—0.10	+0.37	- 0.55	+0.06	20 49 52.63	20 50 02.36	+ 9.95	+0.07
ν Cygni	E	7	-0.10	—0.13	+0.44	— 0.20	+0.07	20 53 03.07	20 53 13.38	+ 9.87	+0.15
ν Aquarie	E	7	-0.11	0.06	+0.34	— 1.30	+0.07	21 03 39.72	21 03 48.71	+ 9.94	+0.08
α Equalte	E	7	—0.12	—0.09	+0.33	— 1.00	+0.08	21 10 21.73	21 10 30.99	+ 9.94	+0.08
1 H. Drac. L. C ..	E	3	—0.12	0.54	— 1.85	— 8.23	+0.09	21 21 46.8	0 21 40.58	+ 0.3	+0.18
1 H. Drac. L. C...	W	3	—0.04	+0.17	2.05	8.23	+0.09	21 21 43.2	....	......	......

Clock correction at 19.2 hours, clock time, +10.010; hourly rate, +0.030.

Collimation = c, clamp E.

	s.
ε Urs. Min	+0.434
51 Ceph. L. C.	+0.318
λ Urs. Min	+0.345
1 H. Drac. L. C.	+0.278
Mean	+0.344
Azimuth...	{ —1.083 { —1.497

TABLE 6.—*Observation equations, Sault Ste. Marie, Mich., July 19, 1893.*

[Epoch, 19.2 hours; clock time. $\Delta t = +10^{s}.00 + \delta\theta$.]

	p.		p.
$-4.31a - 2.33\rho + \delta\theta - 3.70 = v$	0.06	$-37.65a' + 0.33\rho + \delta\theta - 52.7 = v$	0.001
$+0.916a - 2.11\rho + \delta\theta + 1.29 =$	1	$+0.651a' + 0.65\rho + \delta\theta + 0.93 =$	1
$+0.208a - 2.00\rho + \delta\theta + 0.10 =$	1	$+0.739a' + 0.92\rho + \delta\theta + 0.90 =$	1
$-0.168a - 1.71\rho + \delta\theta + 0.22 =$	0.65	$-0.002a' + 0.99\rho + \delta\theta + 0.10 =$	0.74
$+0.914a - 1.66\rho + \delta\theta + 1.10 =$	0.95	$+0.884a' + 1.02\rho + \delta\theta + 1.13 =$	1
$-0.011a - 1.57\rho + \delta\theta - 0.23 =$	0.75	$+0.146a' + 1.13\rho + \delta\theta + 0.13 =$	1
$+0.363a - 1.48\rho + \delta\theta + 0.30 =$	1	$-0.604a' + 1.28\rho + \delta\theta - 1.04 =$	0.45
$-0.140a - 1.28\rho + \delta\theta - 0.13 =$	0.67	$+0.039a' + 1.45\rho + \delta\theta - 0.21 =$	1
$+0.610a - 1.15\rho + \delta\theta + 0.49 =$	1	$-0.538a' + 1.54\rho + \delta\theta - 0.58 =$	0.48
$+0.991a - 1.06\rho + \delta\theta + 0.99 =$	1	$+0.365a' + 1.65\rho + \delta\theta + 0.54 =$	1
$+0.761a - 0.92\rho + \delta\theta - 0.78 =$	1	$+0.132a' + 1.71\rho + \delta\theta + 0.00 =$	1
$-1.482a - 0.80\rho + \delta\theta - 1.87 =$	0.23	$+0.869a' + 1.88\rho + \delta\theta + 1.29 =$	1
$+0.174a - 0.63\rho + \delta\theta + 0.40 =$	1	$+0.668a' + 1.99\rho + \delta\theta + 0.98 =$	1
$+14.88a - 0.35\rho + \delta\theta + 18.4 =$	0.007	$+5.50a' + 2.18\rho + \delta\theta + 8.88 =$	0.06

Normal equations.

$$
\begin{array}{lllll}
[+6.97]a & & -5.75\,\rho & +4.19\,\delta\theta & +7.71 = 0 \\
 & [+6.66]a' & +5.97\,\rho & +4.25\,\delta\theta & +9.66 = 0 \\
-5.75a & +5.97a' & [+43.97]\rho & +0.19\,\delta\theta & +1.21 = 0 \\
+4.19a & +4.25a' & +0.19\,\rho & [+21.05]\delta\theta & +10.33 = 0
\end{array}
$$

Results.

$$
\begin{array}{rl}
 & s. \\
\delta\theta = & +0.019 \\
\rho = & +0.039 \\
a' = & -1.497 \\
a = & -1.083
\end{array}
$$

TABLE 7.—*Time determination, Sault Ste. Marie, Mich., July 20, 1893.*

[First Lieut. Charles S. Riché, observer.]

Star.	Cl.	Number of wires.	b.	Bb.	C. (c. + abn.)	Aa.	Rρ.	Clock time of transit = t.	Right ascension = α.	Clock correction Δt.	$v \bar{p} v$ (co.—ob.).
			s.	s.	s.	s.	s.	h. m. s.	h. m. s.	s.	s.
ε Urs. Min	E	3	−0.03	−0.18	+ 1.39	+ 8.77	+0.06	16 56 43.8	16 57 02.07	+ 8.2	+0.45
ε Urs. Min	W	4	−0.11	−0.66	− 1.60	+ 8.77	+0.06	16 56 47.3	....	....	......
η Ophiuchi.......	W	7	−0.10	−0.05	− 0.31	− 1.86	+0.05	17 04 09.06	17 04 16.96	+10.07	−0.07
π Herculis	W	7	−0.09	−0.11	− 0.38	− 0.42	+0.05	17 11 12.52	17 11 21.51	+ 9.85	+0.15
β Draconis.......	W	7	−0.07	−0.11	− 0.49	+ 0.34	+0.04	17 27 53.96	17 28 03.41	+ 9.67	+0.27
ξ Serpentis.......	W	7	−0.06	−0.03	− 0.31	− 1.86	+0.04	17 31 22.26	17 31 30.18	+10.08	−0.08
ι Herculis	W	7	−0.05	−0.08	− 0.43	− 0.02	+0.04	17 36 19.49	17 36 29.12	+10.12	−0.07
μ Herculis	W	7	−0.04	−0.04	− 0.34	− 0.74	+0.04	17 42 09.58	17 42 18.62	+10.12	−0.12
γ Draconis.......	E	7	+0.04	+0.06	+ 0.44	+ 0.28	+0.03	17 53 59.14	17 54 09.80	+ 9.85	+0.12
72 Ophiuchi.......	E	7	+0.02	+0.01	+ 0.28	− 1.24	+0.03	18 02 09.87	18 02 19.04	+10.09	−0.09
μ Sagittarii	E	7	+0.01	0.00	+ 0.29	− 2.01	+0.03	18 07 16.48	18 07 24.72	+ 9.93	+0.07
η Serpentis.......	E	7	0.00	0.00	+ 0.27	− 1.55	+0.02	18 15 40.23	18 15 48.92	+ 9.95	+0.05
χ Draconis.......	E	7	−0.01	−0.04	+ 0.92	+ 3.01	+0.02	18 22 49.87	18 23 02.67	+ 8.89	+0.53
α Lyræ..........	E	7	−0.03	−0.04	+ 0.35	− 0.35	+0.02	18 33 11.09	18 33 21.40	+10.33	−0.33
51 H. Ceph. L. C ...	E	4	−0.04	+0.50	− 5.31	−30.25	+0.01	18 50 31.4	6 50 05.41	+ 9.0	+0.08
51 H. Ceph. L. C ...	W	3	+0.02	−0.26	+ 5.89	−30.25	+0.01	18 50 21.0	....	....	......
λ Urs. Min	W	3	−0.01	−0.29	−17.89	+76.58	−0.01	19 29 36.3	19 30 52.12	+17.4	−0.22
λ Urs. Min	E	4	+0.05	+2.06	+16.32	+76.58	−0.01	19 28 59.8	....	....	......
β Aquilæ	E	7	+0.05	+0.04	+ 0.27	− 1.32	−0.02	19 49 56.95	19 50 06.02	+10.10	−0.10
θ Aquilæ	E	7	+0.06	+0.04	+ 0.27	− 1.50	−0.02	20 05 40.94	20 05 49.69	+ 9.96	+0.04
o¹ Seq. Cygni	E	7	+0.07	+0.10	+ 0.39	0.00	−0.02	20 10 07.45	20 10 18.20	+10.28	−0.24
α² Capricor	E	7	+0.07	+0.03	+ 0.28	− 1.80	−0.02	20 12 01.76	20 12 09.94	+ 9.69	+0.31
γ Cygni..........	E	7	+0.07	+0.09	+ 0.36	− 0.30	−0.03	20 18 15.24	20 18 25.72	+10.36	−0.36
θ Cephei	E	7	+0.08	+0.16	+ 0.59	+ 1.23	−0.03	20 27 37.91	20 27 49.82	+ 9.96	+0.03
α Cygni	W	7	−0.01	−0.01	− 0.42	− 0.08	−0.04	20 37 39.82	20 37 49.45	+10.18	−0.18
η Cephei	W	7	+0.02	+0.04	− 0.63	+ 1.09	−0.04	20 42 58.93	20 43 09.37	+ 9.98	+0.01
32 Vulpec	W	7	+0.04	+0.04	− 0.34	− 0.74	−0.04	20 49 53.36	20 50 02.37	+10.09	−0.09
ν Cygni	W	7	+0.05	+0.06	− 0.40	− 0.27	−0.04	20 53 03.91	20 53 13.39	+10.13	−0.13
ν Aquarie........	W	7	+0.08	+0.04	− 0.31	− 1.77	−0.05	21 03 40.86	21 03 48.73	+ 9.96	+0.04
α Equulei	W	7	+0.10	+0.07	− 0.30	− 1.36	−0.05	21 10 22.74	21 10 31.01	+ 9.91	+0.09
1 H. Drac. L. C ...	W	3	+0.11	−0.47	+ 2.65	−11.19	−0.05	21 21 47.1	9 21 46.56	+ 8.5	+0.38
1 H. Drac. L. C ...	E	4	+0.06	−0.26	− 2.45	−11.19	−0.05	21 21 52.0	....	....	......

Clock correction at 19.2 hours; clock time, +10.003; hourly rate, −0.024.

Collimation = c, clamp E.

	s.
ε Urs. Min	+0.203
51 Ceph. L. C	+0.272
γ Urs. Min	+0.306
1 H. Drac. L. C	+0.364
Mean	+0.286
Azimuth	−2.034

TABLE 8.—*Observation equations, Sault Ste. Marie, Mich., July 20 1893.*

[Epoch, 19.2 hours, clock time. $\therefore t = +10^{s}.00 + \delta\theta$.]

	p.		p.
$-4.31a - 2.33\rho + \delta\theta - 7.04 = r$	0.06	$-37.65a + 0.33\rho + \delta\theta - 84.0 = r$	0.001
$+0.916a - 2.11\rho + \delta\theta + 1.74 =$	1	$+0.651a + 0.65\rho + \delta\theta + 1.24 =$	1
$+0.208a - 2.00\rho + \delta\theta + 0.52 =$	1	$+0.739a + 0.92\rho + \delta\theta + 1.56 =$	1
$-0.168a - 1.71\rho + \delta\theta - 0.05 =$	0.65	$-0.002a + 0.99\rho + \delta\theta - 0.20 =$	0.74
$+0.914a - 1.66\rho + \delta\theta + 1.74 =$	1	$+0.884a + 1.02\rho + \delta\theta + 2.13 =$	1
$-0.011a - 1.57\rho + \delta\theta - 0.14 =$	0.75	$+0.146a + 1.13\rho + \delta\theta - 0.03 =$	1
$+0.363a - 1.48\rho + \delta\theta + 0.58 =$	1	$-0.604a + 1.28\rho + \delta\theta - 1.16 =$	0.45
$-0.140a - 1.28\rho + \delta\theta - 0.16 =$	0.67	$+0.039a + 1.45\rho + \delta\theta - 0.06 =$	1
$+0.610a - 1.15\rho + \delta\theta + 1.12 =$	1	$-0.538a + 1.54\rho + \delta\theta - 1.03 =$	0.48
$+0.991a - 1.06\rho + \delta\theta + 2.05 =$	1	$+0.365a + 1.65\rho + \delta\theta + 0.69 =$	1
$+0.761a - 0.92\rho + \delta\theta + 1.58 =$	1	$+0.132a + 1.71\rho + \delta\theta + 0.18 =$	1
$-1.482a - 0.80\rho + \delta\theta - 1.92 =$	0.23	$+0.869a + 1.88\rho + \delta\theta + 1.86 =$	1
$+0.174a - 0.63\rho + \delta\theta + 0.00 =$	1	$+0.668a + 1.99\rho + \delta\theta + 1.50 =$	1
$+14.88a - 0.35\rho + \delta\theta + 31.2 =$	0.007	$+5.50a + 2.18\rho + \delta\theta + 12.7 =$	0.06

Normal equations.

$$[+13.67]a + 0.14\rho + 8.47\,\delta\theta + 27.81 = 0$$
$$+0.14a + [+44.14]\rho + 0.11\,\delta\theta + 1.56 = 0$$
$$+8.47a + 0.11\rho + [+21.10]\,\delta\theta + 17.05 = 0$$

Results.

	s.
$\delta\theta =$	$+0.003$
$\rho =$	-0.024
$a =$	-2.034

TABLE 9.—*Time determination, Sault Ste. Marie, Mich., July 26, 1893.*

[First Lieut. Charles S. Riché, observer.]

Star.	Cl.	Number of wires.	b..	Bb.	C. (c.+ abn.).	Aa.	Rp.	Clock time of transit =t.	Right ascension=a.	Clock correction Δt.	√pv (co.—ob.).
			s.	s.	s.	s.	s.	h. m. s.	h. m. s.	s.	s.
ε Urs. Min	W	3	+0.11	+0.66	— 2.26	— 0.79	+0.03	16 56 56.0	16 57 01.23	+7.6	+0.25
ε Urs. Min	E	4	+0.14	+0.86	+ 2.05	— 0.79	+0.03	16 56 51.5	....	......	......
η Ophiuchi	E	7	+0.14	+0.07	+ 0.31	+ 0.17	+0.03	17 04 07.87	17 04 16.93	+8.48	+.12
π Herculis	E	7	+0.15	+0.18	+ 0.37	+ 0.04	+0.03	17 11 12.33	17 11 21.43	+8.48	+.12
β Draconis	E	7	+0.15	+0.25	+ 0.49	— 0.03	+0.02	17 27 54.23	17 28 03.30	+8.34	+.21
ξ Serpentis	E	7	+0.15	+0.07	+ 0.31	+ 0.17	+0.02	17 31 21.15	17 31 30.16	+8.44	+.16
ι Herculis	E	7	+0.15	+0.22	+ 0.43	0.00	+0.02	17 36 19.75	17 36 29.03	+8.61	—.01
μ Herculis	E	7	+0.16	+0.17	+ 0.34	+ 0.07	+0.02	17 42 09.45	17 42 18.56	+8.51	+.09
γ Draconis	W	7	+0.18	+0.30	— 0.52	+ 0.01	+0.02	17 54 01.43	17 54 09.70	+8.46	+.11
72 Ophiuchi	W	7	+0.16	+0.13	— 0.33	— 0.05	+0.01	18 02 10.47	18 02 19.02	+8.79	—.19
μ Sagittarii	W	7	+0.15	+0.06	— 0.35	— 0.08	+0.01	18 07 16.21	18 07 24.72	+8.87	—.27
ν Serpentis	W	7	+0.13	+0.08	— 0.33	— 0.06	+0.01	18 15 40.41	18 15 48.92	+8.81	—.21
χ Draconi	W	7	+0.11	+0.34	— 1.10	+ 0.11	+0.01	18 22 54.27	18 23 02.44	+8.81	—.10
α Lyræ	W	7	+0.09	+0.12	— 0.42	— 0.01	+0.01	18 33 13.00	18 33 21.34	+8.64	—.04
51 H. Ceph. L. C ...	W	3	+0.08	—1.18	+ 9.15	— 1.15	0.00	18 49 56.2	6 50 07.09	+4.1	+.36
51 H. Ceph. L. C ...	E	4	+0.34	—4.80	— 8.57	— 1.15	0.00	18 50 17.5	....	......	......
λ Urs. Min	E	3	+0.21	+8.73	+ 8.50	+24.39	0.00	19 30 01.0	19 30 49.21	+6.6	+.06
λ Urs. Min	W	4	+0.14	+5.89	—10.06	+24.39	0.00	19 30 22.3	....	......	......
β Aquilæ	W	7	+0.14	+0.11	— 0.33	— 0.42	—0.01	19 49 57.96	19 50 06.06	+8.75	—.15
θ Aquilæ	W	7	+0.14	+0.10	— 0.32	— 0.48	—0.01	20 05 41.92	20 05 49.75	+8.54	+.06
o¹ Seq. Cygni	W	7	+0.15	+0.21	— 0.47	0.00	—0.01	20 10 09.74	20 10 18.22	+8.75	—.13
α² Capricor	W	7	+0.15	+0.08	— 0.33	— 0.57	—0.01	20 12 02.46	20 12 10.01	+8.38	+.22
γ Cygni	W	7	+0.15	+0.19	— 0.43	— 0.09	—0.01	20 18 17.30	20 18 25.76	+8.80	—.20
θ Cephei	W	7	+0.15	+0.31	— 0.71	+ 0.39	—0.02	20 27 41.39	20 27 49.84	+8.48	+.09
α Cygni	E	7	+0.22	+0.32	+ 0.42	— 0.04	—0.02	20 37 40.18	20 37 49.51	+8.65	—.05
η Cephei	E	7	+0.23	+0.46	+ 0.62	+ 0.52	—0.02	20 42 59.15	20 43 09.42	+8.69	—.06
32 Vulpec	E	7	+0.23	+0.24	+ 0.33	— 0.35	—0.02	20 49 53.56	20 50 02.44	+8.68	—.08
ν Cygni	E	7	+0.23	+0.30	+ 0.39	— 0.13	—0.02	20 53 04.25	20 53 13.46	+8.67	—.07
ν Aquarii	E	7	+0.23	+0.12	+ 0.31	— 0.83	—0.02	21 03 40.81	21 03 48.82	+8.43	+.17
α Equulei	E	7	+0.23	+0.18	+ 0.30	— 0.64	—0.03	21 10 22.76	21 10 31.10	+8.53	+.07
1 H. Drac. L. C ...	E	3	+0.24	—1.03	— 2.40	— 5.27	—0.03	21 21 46.1	9 21 46.51	+9.1	—.13
1 H. Drac. L. C ...	W	4	+0.17	—0.75	+ 2.61	— 5.27	—0.03	21 21 40.9	....	......	......

Clock correction at 19.2 hours: Clock time, +8.600; hourly rate, —0.013.

Collimation = c, clamp E.

	s.
ε Urs. Min	+0.292
51 Ceph. L. C	+0.430
ε Urs. Min	+0.166
1 H. Drac. L. C	+0.357
Mean	+0.311
Azimuth	+0.183 —0.077 —0.647 —0.958

TABLE 10.—*Observation equations, Sault Ste. Marie, Mich., July 26, 1893.*

[Epoch: Clock time, 19.2 hours, $\Delta t = +8^s.00 + \delta\theta$.]

	p		p.
$-4.31\,a \;-2.23\rho + \delta\theta + 1.18 = v$	0.06	$-37.65\,a'' \;+0.33\rho + \delta\theta - 23.0 = v$	0.001
$+0.916a \;-2.11\rho + \delta\theta - 0.68 =$	1	$+0.651a'' \;+0.65\rho + \delta\theta - 0.32 =$	1
$+0.208a \;-2.00\rho + \delta\theta - 0.55 =$	1	$+0.739a'' \;+0.92\rho + \delta\theta - 0.05 =$	1
$-0.168a \;-1.71\rho + \delta\theta - 0.33 =$	0.65	$+0.002a'' \;+0.99\rho + \delta\theta - 0.74 =$	0.74
$+0.914a \;-1.66\rho + \delta\theta - 0.63 =$	1	$+0.884a'' \;+1.02\rho + \delta\theta + 0.20 =$	1
$-0.011a \;-1.57\rho + \delta\theta - 0.63 =$	0.75	$+0.146a'' \;+1.13\rho + \delta\theta - 0.70 =$	1
$+0.363a \;-1.48\rho + \delta\theta - 0.60 =$	1	$-0.604a'' \;+1.28\rho + \delta\theta - 0.85 =$	0.45
$-0.140a' - 1.28\rho + \delta\theta - 0.49 =$	0.67	$+0.039a''' \;+1.45\rho + \delta\theta - 0.50 =$	1
$+0.610a' - 1.15\rho + \delta\theta - 0.75 =$	1	$-0.538a''' \;+1.54\rho + \delta\theta - 1.10 =$	0.48
$+0.991a' - 1.06\rho + \delta\theta - 0.80 =$	1	$+0.365a''' \;+1.65\rho + \delta\theta - 0.31 =$	1
$+0.761a' - 0.92\rho + \delta\theta - 0.76 =$	1	$+0.132a''' \;+1.71\rho + \delta\theta - 0.52 =$	1
$-1.482a' - 0.80\rho + \delta\theta - 0.93 =$	0.23	$+0.869a''' \;+1.88\rho + \delta\theta + 0.42 =$	1
$+0.174a' - 0.63\rho + \delta\theta - 0.64 =$	1	$+0.668a''' \;+1.90\rho + \delta\theta + 0.14 =$	1
$+14.88\,a' - 0.35\rho + \delta\theta + 5.06 =$	0.007	$+5.50\,a''' + 2.18\rho + \delta\theta + 4.20 =$	0.06

Normal equations.

$$
\begin{array}{llllllll}
[+2.99]a & & & & -3.62\,\rho + & 2.02\,\delta\theta & -1.79 & =0 \\
 & [+4.02]a' & & & -2.21\,\rho + & 2.20\,\delta\theta & -1.04 & =0 \\
 & & [+3.34]a'' & & +1.80\,\rho + & 2.11\,\delta\theta & +0.92 & =0 \\
 & & & [+3.32]a''' & +4.17\,\rho + & 2.14\,\delta\theta & +1.95 & =0 \\
-3.62a & -2.21\,a' & +1.80\,a'' & +4.17\,a''' & [+4.14]\rho + & 1.04\,\delta\theta & +5.40 & =0 \\
+2.02a & +2.20\,a' & +2.11\,a'' & +2.14\,a''' & +1.04\,\rho + & [21.10]\,\delta\theta & -9.52 & =0
\end{array}
$$

Results.

$$
\begin{aligned}
& \qquad\quad s. \\
\delta\theta &= +0.000 \\
\xi &= -0.013 \\
a''' &= -0.958 \\
a'' &= -0.647 \\
a' &= -0.077 \\
a &= +0.183
\end{aligned}
$$

TABLE 11.—*Time determination, Sault Ste. Marie, Mich., August 6, 1893.*

[Prof. Asaph Hall, jr., observer.]

Star	Cl.	Number of wires.	*b.*	*Bb*	*C.* (c. + abn.)	*Aa.*	*Rp.*	Clock time of transit = t	Right ascension = α	Clock correction Δt.	$\sqrt{p}\,v$ (co.—ob).
			s.	s.	s.	s.		h. m. s.	h. m. s.		
ε Urs. Min	E	3	-0.21	—1.24	+ 2.20	+3.22	00	16 56 48.2	16 56 50.56	+7.2	......
ε Urs. Min	W	3	0.07	0.40	— 2.41	+3.22	00	16 56 52.0	......	......	...
η Ophiuchi	W	7	-0.08	—0.04	— 0.30	—0.68	00	17 04 10.71	17 04 16.84	+7.15	+.09
π Herculis	W	7	-0.14	-0.18	— 0.36	-0.16	00	17 11 14.57	17 11 21.27	+7.40	—.16
β Draconis	W	7	—0.11	—0.18	— 0.47	+0.13	00	17 27 56.28	17 28 03.06	+7.29	—.05
ξ Serpentis	W	7	-0.10	-0.05	0.30	—0.66	00	17 31 24.00	17 31 30.10	+7.13	+.11
Herculis	W	7	—0.08	—0.12	0.41	+0.01	00	17 36 22.11	17 36 28.84	+7.25	—.01
μ Herculis	W	7	—0.06	—0.06	— 0.32	—0.35	00	17 42 11.91	17 42 18.45	+7.27	—.03
γ Draconis	E	7	—0.16	-0.28	+ 0.42	+0.10	00	17 54 02.12	17 54 09.49	+7.11	+.11
72 Ophiuchi	E	7	-0.12	-0.10	+ 0.26	-0.46	00	18 02 11.99	18 02 18.96	+7.27	—.03
μ Sagittarii	E	7	—0.11	0.05	+ 0.28	-0.74	00	18 07 17.94	18 07 24.69	+7.26	.02
η Serpentis	E	7	—0.09	0.06	+ 0.26	—0.57	00	18 15 42.04	18 15 48.88	+7.21	+.03
λ Draconis	E	7	-0.07	-0.21	+ 0.87	+1.11	00	18 22 53.32	18 23 01.92	+6.83	+.20
ι Lyræ	E	7	—0.04	0.05	+ 0.33	-0.13	00	18 33 13.66	18 33 21.20	+7.45	—.21
51 H Ceph. L. C	E	3	-0.03	0.38	— 3.46	—11.09	00	18 50 17.9	6 50 10.65	+6.9	+.02
51 H Ceph. L. C	W	4	-0.12	1.08	+ 4.04	-11.09	00	18 50 09.1	....	......	......
λ Urs Min	W	4	-0.14	5.56	—17.78	+39.96	00	19 30 17.3	19 30 42.46	+8.5	—.04
λ Urs Min	E	3	-0.12	5.07	+16.21	+39.96	00	19 29 42.9	....	......	......
β Aquilæ	E	7	—0.12	-0.00	+ 0.26	—0.69	00	19 49 59.42	19 50 06.11	+7.21	+.03
θ Aquilæ	E	7	—0.12	-0.08	0.26	—0.76	00	20 05 43.15	20 05 49.61	+7.26	—.03
ε¹ Seq Cygni	E	7	0.13	—0.18	0.37	0.00	00	20 10 10.59	20 10 18.23	+7.45	—.18
α² Capricor	E	7	—0.13	—0.07	+ 0.27	—0.94	00	20 12 03.68	20 12 10.09	+7.25	—.01
γ Cygni	E	7	—0.13	-0.16	+ 0.34	—0.15	00	20 18 18.37	20 18 25.79	+7.39	—.15
θ Cephei	E	7	—0.13	—0.27	+ 0.56	+0.64	00	20 27 42.80	20 27 40.82	+6.59	+.43
α Cygni	W	7	—0.21	-0.30	— 0.40	—0.04	00	20 37 42.92	20 37 49.56	+7.36	—.14
η Cephei	W	7	—0.21	—0.42	0.60	+0.57	00	20 43 03.13	20 43 09.44	+6.76	+.33
32 Vulpec	W	7	-0.20	—0.21	0.32	—0.39	00	20 49 55.97	20 50 02.53	+7.48	—.24
ν Cygni	W	7	—0.20	—0.26	— 0.38	—0.14	00	20 53 06.93	20 53 13.54	+7.38	—.15
ν Aquarii	W	7	—0.18	—0.10	— 0.30	—0.92	00	21 03 43.20	21 03 48.95	+7.07	+.17
α Equulei	W	7	—0.17	-0.13	0.29	-0.71	00	21 10 25.19	21 10 31.23	+7.17	+.07
1 H Drac. L. C	W	3	—0.16	0.71	2.15	—5.84	00	21 21 43.0	9 21 46.64	+6.0	+.15
1 H Drac. L. C	E	3	—0.07	0.31	— 1.98	-5.84	00	21 21 47.5	....	......	......

Clock correction at 19.2 hours. Clock time, 7.241, hourly rate, 0.000.

Collimation = c, clamp E.

	s.
ε Urs Min	0.312
51 H. Ceph. L. C	+0.182
λ Urs. Min	+0.304
1 H Drac L C	+0.293
Mean	+0.273
Azimuth	{ —0.746 —1.062

TABLE 12.—*Observation equations, Sault Ste. Marie, Mich, August 6, 1893.*

[Epoch, 19.2 hours, clock time. $\Delta t = +7.00 + \delta\theta$.]

	p		p
$-4.31\,a - 2.23\rho + \delta\theta - 3.38 = v$	0.06	$-37.65a' + 0.33\rho + \delta\theta - 41.5 = v$	0.001
$+0.916a - 2.11\rho + \delta\theta + 0.53 =$	1	$+0.651a' + 0.65\rho + \delta\theta + 0.48 =$	1
$+0.208a - 2.00\rho + \delta\theta - 0.24 =$	1	$+0.739a' + 0.92\rho + \delta\theta + 0.52 =$	1
$-0.168a - 1.71\rho + \delta\theta - 0.42 =$	1	$-0.002a' + 0.99\rho + \delta\theta - 0.45 =$	0.74
$+0.914a - 1.06\rho + \delta\theta + 0.55 =$	1	$+0.884a' + 1.02\rho + \delta\theta + 0.69 =$	1
$-0.011a - 1.57\rho + \delta\theta - 0.26 =$	0.75	$+0.146a' + 1.13\rho + \delta\theta - 0.24 =$	1
$+0.363a - 1.48\rho + \delta\theta + 0.08 =$	1	$-0.604a' + 1.28\rho + \delta\theta - 0.23 =$	0.45
$-0.140a - 1.28\rho + \delta\theta - 0.21 =$	0.67	$+0.039a' + 1.45\rho + \delta\theta - 0.34 =$	1
$+0.610a - 1.15\rho + \delta\theta + 0.19 =$	1	$-0.538a' + 1.54\rho + \delta\theta - 0.33 =$	0.48
$+0.991a - 1.06\rho + \delta\theta + 0.48 =$	1	$+0.365a' + 1.65\rho + \delta\theta - 0.09 =$	1
$+0.761a - 0.92\rho + \delta\theta + 0.36 =$	1	$+0.132a' + 1.71\rho + \delta\theta - 0.25 =$	1
$-1.482a - 0.80\rho + \delta\theta - 0.94 =$	0.23	$+0.869a' + 1.88\rho + \delta\theta + 0.85 =$	1
$+0.174a - 0.63\rho + \delta\theta - 0.32 =$	1	$+0.668a' + 1.99\rho + \delta\theta + 0.54 =$	1
$+14.88a - 0.35\rho + \delta\theta + 11.2 =$	0.007	$+5.50a' + 2.18\rho + \delta\theta + 6.22 =$	0.06

Normal equations.

$$[+7.01]a \qquad - 5.83\,\rho + 4.22\,\delta\theta + 4.21 = 0$$
$$[+6.66]a' + 5.97\,\rho + 4.24\,\delta\theta + 6.05 = 0$$
$$-5.83\,a + 5.97a'\,[+44.14]\rho + 0.11\,\delta\theta + 1.95 = 0$$
$$+4.22\,a + 4.25a' + 0.11\rho\,[+21.10]\,\delta\theta + 2.59 = 0$$

Results.

	s.
$\delta\theta =$	$+0.241$
$\rho =$	-0.000
$a' =$	-1.062
$a =$	-0.746

TABLE 13.—*Time determination, Sault Ste. Marie, Mich., August 7, 1893.*

[Prof. Asaph Hall, jr., observer.]

Star.	Cl.	Number of wires.	b.	Bb.	C. (c. + abn.)	Aa.	$R\rho$.	Clock time of transit $= t$.	Right ascension $= \alpha$.	Clock correction. Δt.	$\sqrt{p}\,v$ (co.—ob).
			s.	s.	s.	s.	s.	h. m. s.	h. m. s.	s.	s.
ε Urs. Min	W	4	+0.02	+0.12	−2.46	+3.02	+0.02	16 56 51.6	16 56 59.4	+7.1	+.10
s Urs. Min	E	3	+0.06	+0.38	+2.25	+3.02	+0.02	16 56 46.6	....	....	......
η Ophiuchi	E	7	+0.02	+0.01	+0.33	−0.64	+0.02	17 04 09.71	17 04 16.83	+7.40	+.15
π Herculis	E	7	−0.11	−0.14	+0.39	−0.15	+0.02	17 11 13.40	17 11 21.25	+7.73	−.18
β Draconis	E	7	−0.06	−0.09	+0.52	+0.12	+0.01	17 27 55.13	17 28 03.02	+7.33	+.18
ξ Serpentis	E	7	−0.04	−0.02	+0.33	−0.64	+0.01	17 31 22.84	17 31 30.09	+7.57	−.02
ι Herculis	E	7	−0.02	−0.03	+0.45	+0.01	+0.01	17 36 20.47	17 36 28.83	+7.92	−.32
μ Herculis	E	7	+0.02	+0.02	+0.36	−0.25	+0.01	17 42 10.51	17 42 18.44	+7.79	−.24
γ Draconis	W	7	+0.04	+0.06	−0.55	0.10	0.01	17 54 02.31	17 54 09.47	+7.54	+.01
72 Ophiuchi	W	7	+0.09	+0.07	−0.35	−0.43	+0.01	18 02 12.05	18 02 18.96	+7.61	−.06
μ Sagittarii	W	7	+0.11	+0.05	−0.37	−0.69	+0.01	18 07 18.20	18 07 24.69	+7.49	+.06
η Serpentis	W	7	+0.14	+0.10	−0.35	−0.53	+0.01	18 15 42.26	18 15 48.88	+7.39	+.16
χ Draconis	W	7	+0.17	+0.52	−1.16	+1.04	+0.01	18 22 53.96	18 23 01.88	+7.51	+.02
α Lyræ	W	7	+0.21	+0.27	−0.44	−0.12	0.00	18 33 14.45	18 33 21.25	+7.09	+.46
51 H. Ceph. L. C	W	3	+0.23	−3.29	+9.78	−10.42	0.00	18 50 06.1	6 50 11.07	+8.9	−.10
51 H. Ceph. L. C	E	4	−0.06	+0.78	−9.21	−10.42	0.00	18 50 21.0	....	....	......
λ Urs. Min	E	4	0.04	+1.44	+15.65	+26.39	0.00	19 29 46.8	10 30 41.62	+11.4	−.11
λ Urs. Min	W	3	0.00	+0.12	−17.22	+26.39	0.00	19 30 20.9	....	....	......
β Aquilæ	W	7	+0.04	+0.03	−0.35	−0.46	0.00	19 49 59.38	19 50 06.11	7.51	+.04
θ Aquilæ	W	7	+0.01	+0.01	−0.34	−0.52	−0.01	20 05 43.09	20 05 49.81	+7.58	−.03
o¹ Seq. Cygni	W	7	0.00	0.00	−0.49	0.00	−0.01	20 10 10.88	20 10 18.23	+7.85	−.26
α² Capricor	W	7	0.00	0.00	−0.35	−0.62	−0.01	20 12 03.45	20 12 10.12	+7.65	−.10
γ Cygni	W	7	−0.02	−0.02	−0.45	−0.10	−0.01	20 18 18.66	20 18 25.79	+7.71	−.16
θ Cephei	W	7	−0.04	−0.09	−0.75	+0.42	−0.01	20 27 43.52	20 27 49.81	+6.72	+.53
α Cygni	E	7	−0.04	−0.06	+0.44	−0.03	−0.01	20 37 41.41	20 37 49.56	+7.81	−.26
η Cephei	E	7	−0.02	−0.04	+0.66	+0.38	−0.01	20 43 01.08	20 43 09.43	+7.36	+.13
32 Vulpec	E	7	−0.01	−0.01	+0.35	−0.26	−0.01	20 49 54.86	20 50 02.54	+7.61	−.06
ν Cygni	E	7	0.00	0.00	+0.42	−0.09	−0.01	20 53 05.56	20 53 13.55	+7.67	−.12
ν Aquarii	E	7	+0.02	+0.01	+0.32	−0.61	−0.01	21 03 41.90	21 03 48.97	+7.36	+.19
α Equulei	E	7	+0.03	+0.02	+0.32	−0.47	−0.02	21 10 23.89	21 10 31.25	+7.51	+.04
1 H. Drac. L. C	E	3	+0.04	−0.16	−1.61	−3.86	−0.02	21 21 45.5	9 21 46.68	+6.9	+.17
1 H. Drac. L. C	W	3	−0.02	+0.07	+1.80	−3.86	−0.02	21 21 41.8	....	....	......

Clock correction at 19.2 hours: Clock time, + 7s.548; hourly rate,—0.008.

Collimation = c, clamp E.

	s.
ε Urs. Min	+0.319
51 H. Ceph. L. C	+0.461
λ Urs. Min	+0.294
1 H. Drac. L. C	+0.243
Mean	+0.329
Azimuth	−0.701

TABLE 14.—*Observation equations, Sault Ste. Marie, Mich., August 7, 1893.*

[Epoch. 19.2 hours, clock time. $\Delta t = -7.00 + \delta\theta$.]

	p		p
$-4.31a - 2.23\rho - \delta\theta - 3.16 = v$	0.06	$-37.65a - 0.33\rho - \delta\theta - 30.8 = v$	0.001
$-0.916a - 2.11\rho + \delta\theta - 0.22 =$	1	$-0.651a + 0.65\rho + \delta\theta - 0.05 =$	1
$+0.208a - 2.09\rho - \delta\theta - 0.60 =$	1	$-0.739a + 0.92\rho + \delta\theta - 0.05 =$	1
$-0.168a - 1.71\rho - \delta\theta - 0.46 =$	0.65	$-0.002a - 0.99\rho + \delta\theta - 0.84 =$	0.74
$-0.914a - 1.69\rho - \delta\theta - 0.06 =$	1	$-0.884a - 1.02\rho + \delta\theta - 0.02 =$	1
$-0.011a - 1.57\rho - \delta\theta - 0.94 =$	0.75	$-0.146a + 1.13\rho + \delta\theta - 0.60 =$	1
$-0.363a - 1.48\rho - \delta\theta - 0.55 =$	1	$-0.604a - 1.28\rho + \delta\theta - 0.13 =$	0.45
$-0.140a - 1.28\rho + \delta\theta - 0.65 =$	0.67	$-0.039a - 1.45\rho + \delta\theta - 0.77 =$	1
$+0.610a - 1.15\rho - \delta\theta - 0.19 =$	1	$-0.538a + 1.54\rho + \delta\theta - 0.73 =$	0.48
$+0.951a - 1.06\rho + \delta\theta - 0.19 =$	1	$+0.365a - 1.65\rho + \delta\theta - 0.34 =$	1
$-0.761a - 0.92\rho - \delta\theta + 0.13 =$	1	$-0.132a + 1.71\rho + \delta\theta - 0.57 =$	1
$-1.482a - 0.80\rho - \delta\theta - 1.56 =$	0.23	$+0.869a + 1.88\rho + \delta\theta + 0.26 =$	1
$+0.174a - 0.63\rho + \delta\theta - 0.03 =$	1	$-0.668a + 1.99\rho + \delta\theta - 0.02 =$	1
$-14.88a - 0.35\rho + \delta\theta + 8.51 =$	0.007	$-5.50a + 2.18\rho + \delta\theta + 4.02 =$	0.06

Normal equations.

$$
\begin{aligned}
[-13.68]a - 0.14\,\rho - 8.47\,\delta\theta + 5.00 &= 0 \\
+0.14\,a\,[+44.14]\rho + 0.11\,\delta\theta + 0.50 &= 0 \\
+8.47\,a + 0.11\rho\,[+21.10]\,\delta\theta - 5.50 &= 0
\end{aligned}
$$

Results.

$$
\begin{aligned}
\delta\theta &= +0.548 \text{ s.} \\
\rho &= -0.008 \\
a &= -0.701
\end{aligned}
$$

TABLE 15.—*Time determination, Sault Ste. Marie, Mich., August 8, 1893.*

[Prof. Asaph Hall, jr., observer.]

Star.	Cl.	Number of wires.	*b.*	*Bb.*	*C.* (c. + abn.).	*Aa.*	*Rρ.*	Clock time of transit $=t$.	Right ascension $=a$.	Clock correction Δt.	$\sqrt{p}\,v$ (co. — ob.).
			s.	*s.*	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*
ε Urs. Min	E	3	+0.12	+0.72	+ 1.10	+ 3.55	+0.06	16 56 46.3	16 56 59.26	+ 7.6	+ .07
ε Urs. Min	W	4	—0.01	—0.05	— 1.31	+ 3.55	+0.06	16 56 49.4	....	......	.....
η Ophiuchi	W	7	—0.04	—0.02	— 0.26	— 0.75	+0.05	17 04 10.08	17 04 16.82	+ 7.72	+ .18
ι Herculis	W	7	—0.16	—0.19	— 0.31	— 0.17	+0.05	17 11 13.81	17 11 21.24	+ 8.05	— .15
β Draconis	W	7	+0.03	+0.05	— 0.41	+ 0.14	+0.04	17 27 55.39	17 28 03.01	+ 7.80	+ .08
ξ Serpentis	W	7	+0.04	+0.02	— 0.26	— 0.75	+0.04	17 31 23.24	17 31 30.08	+ 7.79	+ .11
ι Herculis	W	7	+0.04	+0.06	— 0.36	+ 0.01	+0.04	17 36 21.03	17 36 28.80	+ 8.02	— .10
μ Herculis	W	7	+0.05	+0.05	— 0.28	— 0.30	+0.04	17 42 11.06	17 42 18.43	+ 7.86	+ .04
γ Drayconis	E	7	+0.02	+0.02	+ 0.36	+ 0.12	+0.03	17 54 01.04	17 54 09.44	+ 7.87	+ .02
72 Ophiuchi	E	7	+0.01	+0.01	+ 0.23	— 0.50	+0.03	18 02 11.24	18 02 18.95	+ 7.94	— .04
μ Sagittarii	E	7	+0.01	0.00	+ 0.24	— 0.82	+0.03	18 07 17.34	18 07 24.68	+ 7.89	+ .01
η Serpentis	E	7	0.00	0.00	+ 0.22	— 0.63	+0.02	18 15 41.29	18 15 48.87	+ 7.97	— .07
χ Draconis	E	7	0.00	+0.01	+ 0.75	+ 1.22	+0.02	18 22 51.89	18 23 01.82	+ 7.93	— .01
α Lyræ	E	7	0.00	0.00	+ 0.29	— 0.14	+0.02	18 32 13.01	18 33 21.24	+ 8.06	— .16
51 H. Ceph. L. C	E	3	+0.11	—1.52	— 3.07	—12.24	+0.01	18 50 16.8	6 50 11.50	+11.5	— .29
51 H. Ceph. L. C	W	4	0.00	—0.28	+ 3.65	—12.24	+0.01	18 50 08.9	....	......	.....
λ Urs. Min	W	4	+0.03	+1.15	—15.48	+30.99	—0.01	19 30 14.6	19 30 41.19	+ 9.9	— .06
λ Urs. Min	E	3	+0.12	+4.94	+13.92	+30.99	—0.01	19 29 41.5	....	......	.....
β Aquilæ	E	7	+0.12	+0.09	+ 0.22	— 0.54	—0.02	19 49 58.41	19 50 06.11	+ 7.95	— .05
θ Aquilæ	E	7	+0.05	+0.03	+ 0.22	— 0.61	—0.02	20 05 42.45	20 05 49.81	+ 7.74	+ .16
o[1] Seq. Cygni	E	7	+0.02	+0.04	+ 0.32	0.00	—0.03	20 10 09.65	20 10 18.22	+ 8.24	— .29
α[2] Capricor	E	7	+0.01	+0.01	+ 0.23	— 0.73	—0.03	20 12 02.75	20 12 10.10	+ 7.87	+ .03
γ Cygni	E	7	—0.02	—0.03	+ 0.29	— 0.12	—0.03	20 18 17.54	20 18 25.79	+ 8.14	— .24
θ Cephei	E	7	—0.10	—0.20	+ 0.48	+ 0.50	—0.03	20 27 41.10	20 27 49.80	+ 7.95	— .03
α Cygni	W	7	—0.01	—0.01	— 0.35	— 0.03	—0.04	20 37 42.07	20 37 49.56	+ 7.92	— .02
η Cephei	W	7	+0.06	+0.12	— 0.52	+ 0.44	—0.04	20 43 01.85	20 43 09.43	+ 7.58	+ .22
32 Vulpec	W	7	+0.11	+0.12	— 0.28	— 0.30	—0.04	20 49 55.01	20 50 02.54	+ 8.03	— .13
ν Cygni	W	7	+0.15	+0.20	— 0.33	— 0.11	—0.04	20 53 06.05	20 53 13.55	+ 7.88	+ .02
ν Aquarii	W	7	+0.15	+0.08	— 0.26	— 0.72	—0.05	21 03 42.15	21 03 48.97	+ 7.77	+ .13
α Equulei	W	7	+0.14	+0.11	— 0.25	— 0.55	—0.05	21 10 24.24	21 10 31.25	+ 7.75	+ .15
1 H. Drac. L. C	W	3	+0.14	—0.62	+ 2.59	— 4.53	—0.06	21 21 41.4	9 21 46.71	+ 7.9	.00
1 H. Drac. L. C	E	3	—0.01	+0.05	— 2.40	— 4.53	—0.06	21 21 45.8	....	......	.....

Clock correction at 19.2 hours: Clock time, + 7.905; hourly rate, — 0.025.

Collimation = c, clamp East.

	s.
ε Urs. Min	+ 0.163
51 H. Ceph. L. C	+ 0.163
λ Urs. Min	+ 0.263
1 H. Drac. L. C	+ 0.356
Mean	+ 0.236
Azimuth	— 0.823

TABLE 16.—*Observation equations, Sault Ste. Marie, Mich., August 8, 1893.*

[Epoch, 19.2 hours, clock time. $\therefore t = 7^s.00 + \delta\theta$.]

	p		p
$-4.31a - 2.23\rho + \delta\theta - 4.18 = r$	0.06	$-37.65a + 0.33\rho + \delta\theta - 33.9 = r$	0.001
$+0.916a - 2.11\rho + \delta\theta - 0.02 =$	1	$+0.651a + 0.65\rho + \delta\theta - 0.39 =$	1
$+0.208a - 2.00\rho + \delta\theta - 0.93 =$	1	$+0.739a + 0.92\rho + \delta\theta - 0.11 =$	1
$-0.168a - 1.71\rho + \delta\theta - 0.98 =$	0.65	$-0.002a + 0.99\rho + \delta\theta - 1.21 =$	0.74
$+0.914a - 1.66\rho + \delta\theta - 0.08 =$	1	$+0.884a + 1.02\rho + \delta\theta - 0.11 =$	1
$-0.011a - 1.57\rho + \delta\theta - 1.07 =$	0.75	$+0.146a + 1.13\rho + \delta\theta - 0.99 =$	1
$+0.363a - 1.48\rho + \delta\theta - 0.60 =$	1	$-0.604a + 1.28\rho + \delta\theta - 1.42 =$	0.45
$-0.140a - 1.28\rho + \delta\theta - 1.02 =$	0.67	$+0.039a + 1.45\rho + \delta\theta - 0.83 =$	1
$+0.610a - 1.15\rho + \delta\theta - 0.47 =$	1	$-0.538a + 1.54\rho + \delta\theta - 0.98 =$	0.48
$+0.991a - 1.06\rho + \delta\theta - 0.10 =$	1	$+0.365a + 1.65\rho + \delta\theta - 0.69 =$	1
$+0.761a - 0.92\rho + \delta\theta - 0.36 =$	1	$+0.132a + 1.71\rho + \delta\theta - 0.73 =$	1
$-1.482a - 0.80\rho + \delta\theta - 2.17 =$	0.23	$+0.869a + 1.88\rho + \delta\theta - 0.00 =$	1
$+0.174a - 0.63\rho + \delta\theta - 0.94 =$	1	$+0.668a + 1.99\rho + \delta\theta - 0.15 =$	1
$+14.88a - 0.35\rho + \delta\theta + 7.74 =$	0.007	$+5.50a + 2.18\rho + \delta\theta + 3.70 =$	0.06

Normal equations.

$$
\begin{aligned}
[+13.68]a + 0.14\rho + 8.47\,\delta\theta + 3.59 &= 0 \\
+0.14a\ [+44.14]\rho + 0.11\,\delta\theta + 1.19 &= 0 \\
+8.47a + 0.11\rho\ [+21.10]\,\delta\theta - 12.16 &= 0
\end{aligned}
$$

Results.

$$
\begin{aligned}
\delta\theta &= +0^s.905 \\
\rho &= -0.025 \\
a &= -0.823
\end{aligned}
$$

TABLE 17.—*Time determination, Sault Ste. Marie, Mich., August 9, 1893.*

[Prof. Asaph Hall, jr., observer.]

Star	Cl.	Number of wires	b	Bb.	C (c + abn.).	Aa.	Rp.	Clock time of transit = t.	Right ascension = α.	Clock correction Δt	v p v (co. — ob.).
			s.	s.	s.	s.	s.	h. m. s.	h. m. s.	s.	s.
ε Urs. Min.	W	3	+0.06	0.20	−1.85	+2.57	−0.06	16 56 51.0	16 56 50.19	7.3	.22
ε Urs. Min	E	3	+0.12	0.72	1.65	2.57	−0.06	16 56 47.0	....	......	.....
η Ophiuchi	E	7	0.13	0.06	0.29	−0.55	−0.05	17 04 08.09	17 04 10.81	8.07	.11
π Herculis	E	7	0.12	0.15	0.35	0.12	−0.05	17 11 12.63	17 11 21.22	8.26	−.08
β Draconis	E	7	0.12	0.18	+0.46	0.10	−0.04	17 27 54.11	17 28 02.97	8.15	+.02
ξ Serpentis	E	7	0.11	0.08	0.29	−0.54	−0.04	17 31 21.97	17 31 30.07	8.33	−.15
ι Herculis	E	7	0.11	0.10	0.41	0.01	−0.04	17 38 19.87	17 38 28.79	8.38	−.17
μ Herculis	E	7	0.11	0.12	0.32	−0.22	0.04	17 42 09.98	17 42 18.41	8.25	−.07
γ Draconis	W	7	0.07	0.11	−0.50	0.08	−0.03	17 55 01.58	17 54 09.42	8.18	.00
72 Ophiuchi	W	7	−0.00	−0.07	−0.32	−0.36	0.03	18 02 11.50	18 02 18.94	8.22	−.03
μ Sagittarii	W	7	+0.02	−0.01	−0.33	−0.50	−0.03	18 07 17.52	18 07 24.07	8.11	+.07
η Serpentis	W	7	+0.07	0.05	−0.31	0.45	−0.02	18 15 41.55	18 15 48.90	8.04	+.14
χ Draconis	W	7	0.19	+0.57	−1.05	0.88	0.02	18 22 53.43	18 23 01.76	7.85	+.11
α Lyræ	W	7	0.20	0.26	−0.40	−0.10	−0.02	18 33 13.41	18 33 21.22	8.07	.11
51 H. Ceph. L. C.	W	3	0.21	−2.08	8.20	−8.86	0.01	18 50 06.1	6 50 11.92	0.5	−.10
51 H. Ceph. L. C	E	4	0.08	−1.09	−7.62	−8.86	−0.01	18 50 20.0	....	......	......
λ Urs. Min	E	2	0.09	3.03	37.70	22.41	0.01	*19 29 24.4	19 30 39.79	+11.0	−.10
λ Urs. Min	W	2	0.10	4.00	−39.35	22.44	0.01	*19 30 41.[illegible]	....	......	......
β Aquilæ	W	7	0.04	+0.03	−0.31	−0.39	+0.02	19 49 58.55	19 50 06.11	8.21	−.03
θ Aquilæ	W	7	0.05	+0.04	−0.31	−0.44	0.02	20 03 42.52	20 03 49.81	7.96	+.20
α¹ Seq Cygni	W	7	0.06	+0.09	−0.45	0.00	0.03	20 10 10.00	20 10 18.22	8.55	−.32
α² Capricor	W	7	+0.06	+0.03	0.32	0.51	0.03	20 12 02.75	20 12 10.10	8.14	+.04
γ Cygni	W	7	0.07	+0.00	−0.41	−0.09	+0.03	20 18 17.88	20 18 25.79	8.29	−.11
δ Cephei	W	7	+0.09	+0.19	−0.68	0.36	+0.03	20 27 42.06	20 27 49.79	7.83	+.23
ε Cygni	E	7	+0.02	+0.02	0.40	−0.02	+0.04	20 37 40.61	20 37 49.50	8.51	−.33
η Cephei	E	7	+0.03	0.06	0.59	0.32	+0.04	20 43 00.50	20 43 08.42	7.91	+.19
32 Vulpec	E	7	0.04	+0.04	0.32	0.22	+0.04	20 49 54.22	20 50 02.55	8.15	+.03
ν Cygni	E	7	0.05	+0.06	0.37	0.08	0.04	20 53 04.80	20 53 13.55	8.36	−.18
ν Aquarii	E	7	0.05	0.03	0.29	−0.52	+0.05	21 03 40.96	21 03 48.96	8.17	+.01
α Equulei	E	7	0.02	0.02	0.29	−0.40	+0.05	21 10 23.27	21 10 31.26	8.03	+.15
1 H. Drac L. C	E	3	0.01	−0.03	−1.90	−3.28	+0.06	21 21 44.3	9 21 48.73	7.5	+.17
1 H. Drac L. C	W	3	0.02	−0.09	2.00	−3.28	+0.06	21 21 40.6	....	......	.....

*Rejected, star dim.

Clock correction at 19.2 hours Clock time, +8.184, hourly rate, +0.026.

Collimation = c, clamp East.

	s.
ε Urs. Min	+0.237
51 H. Ceph. L. C	+0.384
λ Urs. Min	+0.090
1 H. Drac. L. C	+0.271
Mean	+0.297
Azimuth	−0.596

TABLE 18.—*Observation equations, Sault Ste. Marie, Mich., August 9, 1898.*

[Epoch, 19.2 hours, clock time. $\Delta t = +8.00 + \delta\theta$.]

Equation	p	Equation	p
$-4.31a - 2.23\rho + \delta\theta - 1.63 = v$	0.06	$+0.651a + 0.65\rho + \delta\theta + 0.16 = v$	1
		$-0.739a - 0.92\rho + \delta\theta + 0.44 =$	1
$+0.916a - 2.11\rho + \delta\theta - 0.53 =$	1	$-0.002a + 0.99\rho + \delta\theta - 0.58 =$	0.74
$+0.298a - 2.09\rho + \delta\theta - 0.09 =$	1	$+0.844a - 1.02\rho + \delta\theta - 0.36 =$	1
$-0.168a - 1.71\rho + \delta\theta - 0.21 =$	0.65	$+0.146a + 1.13\rho + \delta\theta - 0.23 =$	1
$+0.914a - 1.66\rho + \delta\theta + 0.25 =$	1	$-0.604a + 1.28\rho + \delta\theta - 0.22 =$	0.45
$-0.011a - 1.57\rho + \delta\theta - 0.25 =$	0.75		
$+0.363a - 1.48\rho + \delta\theta - 0.01 =$	1	$-0.039a + 1.45\rho + \delta\theta - 0.53 =$	1
		$-0.538a + 1.54\rho + \delta\theta - 0.27 =$	0.48
$-0.140a - 1.28\rho + \delta\theta - 0.23 =$	0.67	$+0.365a + 1.65\rho + \delta\theta + 0.03 =$	1
$+0.610a - 1.15\rho + \delta\theta - 0.17 =$	1	$+0.132a + 1.71\rho + \delta\theta - 0.32 =$	1
$+0.991a - 1.06\rho + \delta\theta + 0.51 =$	1	$-0.869a + 1.88\rho + \delta\theta + 0.30 =$	1
$+0.761a - 0.92\rho + \delta\theta + 0.43 =$	1	$+0.668a + 1.99\rho + \delta\theta + 0.32 =$	1
$-1.482a - 0.80\rho + \delta\theta - 0.81 =$	0.23		
$+0.174a - 0.68\rho + \delta\theta - 0.05 =$	1	$+5.50a - 2.18\rho + \delta\theta + 3.76 =$	0.06
$+14.88a - 0.35\rho + \delta\theta + 7.39 =$	0.007		

Normal equations.

$$
\begin{aligned}
[+12.26]a &+ 0.15\rho + 8.51\,\delta\theta + 5.73 = 0 \\
+0.15a &+ [+44.14]\rho + 0.11\,\delta\theta - 1.06 = 0 \\
+8.51a &+ 0.11\rho + [+21.10]\,\delta\theta + 1.16 = 0
\end{aligned}
$$

Results.

$$
\begin{aligned}
& \quad\ s. \\
\delta\theta &= +0.184 \\
\rho &= +0.028 \\
a &= -0.596
\end{aligned}
$$

TABLE 19.—*Time determination, Sault Ste. Marie, Mich., August 12, 1893.*

[Prof. Asaph Hall, jr., observer.]

Star.	Cl.	Number of wires.	b.	Bb.	C. (c. + abn.).	Aa.	Rp.	Clock time of transit = t.	Right ascension = α.	Clock correction Δ t.	$\sqrt{2}\,v$ (co.—ob.).
				s.	s.	s.	s.	h. m. s.	h. m. s.	s.	s
ε Urs. Min	E	3	+0.14	+0.81	+ 1.31	+ 1.24	−0.04	16 56 47.2	16 56 58.57	+8.0	+.24
ε Urs. Min	W	4	+0.12	+0.72	− 1.51	+ 1.24	−0.04	16 56 50.1	....	......	.....
η Ophiuchi	W	7	+0.09	+0.05	− 0.28	− 0.26	−0.04	17 04 08.49	17 04 16.78	+8.82	+.18
π Herculis	W	7	0.00	−0.01	− 0.34	− 0.06	−0.04	17 11 12.49	17 11 21.16	+9.12	−.12
β Draconis.......	W	7	−0.07	−0.12	− 0.44	− 0.05	−0.03	17 27 54.41	17 28 02.89	+9.02	−.02
ξ Serpentis	W	2	−0.04	−0.02	− 0.28	− 0.26	−0.03	17 31 21.84	17 31 30.04	+8.79	+.16
ι Herculis........	W	7	−0.03	−0.04	− 0.39	0.00	−0.03	17 36 20.48	17 36 28.72	+8.70	+.26
μ Herculis	W	7	−0.01	−0.01	− 0.31	− 0.10	−0.03	17 42 09.81	17 42 18.37	+9.01	−.01
γ Draconis	E	7	−0.06	−0.10	+ 0.39	+ 0.08	−0.03	17 53 59.61	17 54 09.35	+9.40	−.33
72 Ophiuchi	E	7	−0.08	−0.06	+ 0.25	− 0.35	−0.02	18 02 10.02	18 02 18.91	+9.07	−.07
μ Sagittarii.......	E	7	−0.08	−0.03	+ 0.26	− 0.57	−0.02	18 07 16.01	18 07 24.65	+9.00	.00
ν Serpentis	E	7	−0.08	−0.05	+ 0.25	− 0.44	−0.02	18 15 40.14	18 15 48.84	+8.96	+.04
χ Draconis	E	7	−0.09	−0.28	+ 0.82	+ 0.86	−0.02	18 22 51.18	18 23 01.59	+9.03	−.01
α Lyræ	E	7	−0.10	−0.13	+ 0.31	− 0.10	−0.01	18 33 11.76	18 33 21.18	+9.35	−.35
51 H. Ceph. L. C...	E	3	−0.10	+1.39	− 4.16	− 8.61	−0.01	18 50 15.6	6 50 13.05	+8.8	+.02
51 H. Ceph. L. C...	W	4	−0.04	+0.53	+ 4.74	− 8.61	−0.01	18 50 07.6	....	......	.....
λ Urs. Min	W	4	−0.05	−1.98	−16.77	+ 33.72	+0.01	19 30 13.8	19 30 37.10	+8.3	+.02
λ Urs. Min........	E	3	−0.06	−2.27	+15.20	+ 33.72	+0.01	19 29 42.2	....	......	.....
β Aquilæ	E	7	+0.02	+0.01	+ 0.25	− 0.58	+0.01	19 49 57.61	19 50 06.11	+8.81	+.19
θ Aquilæ	E	7	+0.01	+0.01	+ 0.24	− 0.66	+0.02	20 05 41.17	20 05 49.82	+9.04	−.04
o¹ Seq. Cygni	E	7	+0.01	+0.01	+ 0.35	0.00	+0.02	20 10 08.60	20 10 18.20	+9.22	−.19
α² Capricor	E	7	+0.01	+0.01	+ 0.25	− 0.79	+0.02	20 12 01.58	20 12 10.11	+9.04	−.04
γ Cygni...........	E	7	+0.01	+0.01	+ 0.32	− 0.13	+0.02	20 18 16.52	20 18 25.78	+9.04	−.04
θ Cephei..........	E	7	0.00	+0.01	+ 0.53	+ 0.54	+0.03	20 27 39.85	20 27 49.76	+8.80	+.13
α Cygni	W	7	+0.02	−0.03	− 0.38	− 0.03	+0.03	20 37 40.95	20 37 49.55	+8.95	+.05
ι Cephei	W	7	−0.02	−0.05	− 0.57	+ 0.48	+0.03	20 43 01.07	20 43 09.40	+8.44	+.39
ν Cygni	W	7	−0.09	−0.12	− 0.36	− 0.12	+0.03	20 53 05.08	20 53 13.56	+9.05	−.05
ν Aquarii	W	7	−0.12	−0.06	− 0.28	− 0.78	+0.04	21 03 40.87	21 03 49.00	+9.21	−.21
α Equulei.........	W	7	−0.14	−0.10	− 0.27	− 0.60	+0.04	21 10 23.22	21 10 31.28	+8.99	+.01
1 H. Drac. L. C...	W	3	−0.16	+1.15	+ 2.45	− 4.93	+0.04	21 21 40.2	9 21 46.88	+8.0	+.24
1 H. Drac. L. C...	E	4	−0.29	+1.27	− 2.25	− 4.93	+0.04	21 21 44.8	....	......	.....

Clock correction at 19.2 hours: Clock time, − 9s.004; hourly rate, + 0.020.

Collimation = c, clamp East.

	s.
ε Urs. Min..................	+0.191
51 H. Ceph. L. C	+0.216
λ Urs. Min..................	+0.286
1 H. Drac L. C	+0.335
Mean	+0.257
Azimuth..............	−0.288
	−0.579
	−0.896

TABLE 20.—*Observation equations, Sault Ste. Marie, Mich., August 12, 1893.*

[Epoch, 19.2 hours, clock time. $\Delta t = +\ 9.00 + \delta\theta$.]

	p.		p.
$-4.31\ a\ -2.23\rho + \delta\theta - 0.25 = v$	0.06	$-37.65\ a'' + 0.33\rho + \delta\theta - 33.0 = v$	0.001
$+0.916a\ -2.11\rho + \delta\theta + 0.48 =$	1	$+0.651a'' + 0.65\rho + \delta\theta + 0.76 =$	1
$+0.208a\ -2.00\rho + \delta\theta - 0.02 =$	1	$+0.739a'' + 0.92\rho + \delta\theta + 0.60 =$	1
$-0.168a\ -1.71\rho + \delta\theta - 0.04 =$	0.65	$-0.002a'' + 0.90\rho + \delta\theta - 0.24 =$	0.74
$+0.914a\ -1.66\rho + \delta\theta + 0.50 =$	0.57	$+0.884a'' + 1.02\rho + \delta\theta + 0.73 =$	1
$-0.011a\ -1.57\rho + \delta\theta + 0.33 =$	0.75	$+0.146a'' + 1.13\rho + \delta\theta + 0.07 =$	1
$+0.363a\ -1.48\rho + \delta\theta + 0.12 =$	1	$-0.604a'' + 1.28\rho + \delta\theta - 0.37 =$	0.45
$-0.140a' - 1.28\rho + \delta\theta - 0.45 =$	0.67	$+0.039a'' + 1.45\rho + \delta\theta + 0.05 =$	1
$+0.610a' - 1.15\rho + \delta\theta + 0.30 =$	1	$-0.538a'' + 1.54\rho + \delta\theta + 0.05 =$	0.48
$+0.991a' - 1.06\rho + \delta\theta + 0.59 =$	1		
$+0.761a' - 0.92\rho + \delta\theta + 0.50 =$	1	$+0.132a'' + 1.71\rho + \delta\theta + 0.04 =$	1
$-1.482a' - 0.80\rho + \delta\theta - 0.87 =$	0.23	$+0.869a'' + 1.88\rho + \delta\theta + 0.53 =$	1
$+0.174a' - 0.63\rho + \delta\theta - 0.24 =$	1	$+0.668a'' + 1.99\rho + \delta\theta + 0.57 =$	1
$+14.88a' - 0.35\rho + \delta\theta + 8.80 =$	0.007	$5.50a'' + 2.18\rho + \delta\theta + 5.93 =$	0.06

Normal equations.

$$[+2.63]a \qquad\qquad\qquad\qquad - 2.97\rho + 1.63\ \delta\theta + 0.81 = 0$$
$$[+4.02]a' \qquad\qquad - 2.21\rho + 2.20\ \delta\theta + 2.36 = 0$$
$$[+6.53]a'' + 5.37\rho + 3.89\ \delta\theta + 5.73 = 0$$
$$-2.97a - 2.21\ a' + 5.37a'' \ [+40.20]\rho + 0.70\ \delta\theta + 1.87 = 0$$
$$+1.63a + 2.20\ a' + 3.89a'' + 0.70\ \rho\ [+19.67]\delta\theta + 5.12 = 0$$

Results.

	s.
$\delta\theta$ =	+0.004
ρ =	+0.020
a'' =	−0.896
a' =	−0.579
a =	−0.288

TABLE 21.—*Time determination, Ann Arbor, Mich., July 10, 1893.*

[Prof. Asaph Hall, jr., observer.]

Star.	Vision.	Number of wires.	b	Bb.	C (c + abn.).	Aa	Rp.	Chron. time of transit = t.	Right ascension = α.	Chron. correction Δt.	$\sqrt{p}$ v (co.—ob.).
			s	*s*	*s.*	*s.*	*s.*	*h. m. s*	*h. m. s.*	*s.*	*s.*
β Urs. Min.	Ref	5	−0.04	−0.12	−0.92	−0.23	−0.25	14 51 58.74	14 51 04.63	−52.59	−.01
β Urs. Min.	Dir	4	0.04	+0.12	0.92	−0.23	−0.25	14 51 58.50			
β Libræ	D	11	+0.02	+0.01	−0.25	+0.09	−0.22	15 12 09.85	15 11 16.83	−52.65	+.03
γ² Urs. Min.	D		+0.02	+0.06	−0.81	−0.18	−0.20	15 21 51.02	15 20 57.56	−52.3[illegible]	−.14
ν¹ Bootis.	D		0.02	+0.03	0.33	0.00	0.19	15 28 00.45	15 27 07.33	−52.03	+.01
γ Libræ	D		0.02	+0.01	0.26	0.10	−0.19	15 30 27.44	15 29 34.49	52.61	.01
ε Serpentis. ..	D		0.02	+0.02	−0.25	0.07	−0.16	15 39 54.86	15 39 01.86	−52.66	.04
μ Serpentis	D		+0.02	+0.02	0.25	+0.08	0.17	15 44 57.14	15 44 04.18	−52.64	+.02
β¹ Scorpii		11	0.02	+0.01	−0.26	+0.11	−0.14	16 00 08.04	15 59 15.12	−52.64	.02
δ Ophiuchi. .	D	11	+0.02	+0.01	0.25	+0.08	−0.13	16 09 39.38	16 08 46.44	−52.65	.03
τ Herculis	D	11	0.02	0.03	0.30	−0.01	−0.12	16 17 26.92	16 16 33.76	−52.70	.07
β Herculis .	D	11	0.02	+0.02	0.27	+0.04	−0.10	16 26 82.29	16 25 30.37	52.61	−.01
σ Herculis	D	11	−0.02	0.03	0.33	0.00	−0.09	16 31 34.57	16 30 41.58	−52.00	−.03
η Herculis	D	11	+0.02	0.05	0.32	0.01	−0.08	16 40 08.97	16 39 16.04	−52.57	−.06
ε Urs. Min.	Ref	4	0.02	0.13	1.82	−0.54	0.05	16 57 58.60	16 57 03.28	−52.78	+.04
ε Urs. Min.	Dir	5	0.02	+0.13	−1.82	−0.54	−0.05	16 57 58.34			
δ Urs. Min. .	Ref	5	−0.07	0.90	4.16	−1.33	+0.06	18 08 01.10	18 07 03.24	−51.53	−.11
δ Urs. Min.	Dir	3	0.07	0.90	−4.16	−1.33	+0.06	18 07 59.30			
109 Herculis	D	8	0.04	0.04	0.27	0.04	+0.06	18 20 03.42	18 19 10.72	−52.50	−.09
χ Draconis	D	9	−0.04	+0.13	−0.83	−0.19	+0.08	18 23 56.63	18 23 02.95	52.87	.12
α Lyræ	D	11	+0.04	+0.05	−0.32	+0.01	+0.10	18 34 14.11	18 33 21.41	−52.54	−.08
110 Herculis	D	11	+0.04	+0.04	0.26	+0.04	+0.11	18 41 58.51	18 41 05.81	−52.63	+.01
R Lyræ	D	11	+0.04	+0.06	−0.34	0.00	+0.13	18 53 00.07	18 52 07.22	−52.70	.06
λ Aquilæ	D	11	0.04	0.03	−0.25	+0.08	+0.14	19 01 29.44	19 00 36.84	−52.60	−.02
δ Aquilæ.... ...	D	11	0.04	0.03	−0.25	+0.07	0.17	19 21 01.32	19 20 08.74	−52.60	−.02
ι Cygni	D	11	0.04	0.05	−0.40	−0.03	+0.13	19 27 55.95	19 27 03.05	−52.70	+.07
θ Cygni	D	11	+0.04	+0.05	−0.38	−0.02	+0.19	19 34 29.62	19 33 36.81	52.65	.02
δ Cygni	D	11	+0.04	+0.05	0.35	−0.01	+0.20	19 42 33.00	19 41 40.28	−52.61	−.01
η Aquilæ.... ..	D	11	+0.03	0.03	−0.25	+0.06	+0.21	19 46 28.72	19 45 36.24	−52.53	−.09
β Aquilæ	D	11	+0.03	0.03	−0.25	+0.07	+0.22	19 50 58.41	19 50 05.91	52.57	−.05
χ Cephei......	Ref	4	−0.04	0.16	1.13	−0.30	0.25	20 13 27.34	20 12 33.04	−52.96	+.12
χ Cephei	Dir	4	+0.04	+0.16	−1.13	−0.30	+0.25	20 13 27.02			

Chronometer correction at 17.5 hours: Chronometer time, −52.619, hourly rate, +0.094; azimuth, +0.113

Collimation—c, Tel. D.

	s.
	−0.231
	−0.230
Mean	−0.230

TABLE 22.—*Observation equations, Ann Arbor, Mich., July 10, 1893.*

[Epoch, 17.5 hours, $\Delta t = -52.00 + \delta\theta$.]

Equation	p.	Equation	p.
$-2.01a - 2.68\rho + \delta\theta + 1.07 = v$	0.165	$-11.82a + 0.60\rho + \delta\theta + 0.80 = v$	0.01
$+0.79a - 2.33\rho + \delta\theta + 0.78 =$	1	$+0.38a + 0.80\rho + \delta\theta + 0.47 =$	0.96
$-1.63a - 2.18\rho + \delta\theta + 0.71 =$	0.24	$-1.70a + 0.87\rho + \delta\theta + 0.98 =$	0.223
$+0.02a - 2.06\rho + \delta\theta + 0.82 =$	1	$+0.08a + 1.04\rho + \delta\theta + 0.43 =$	1
$+0.86a - 2.03\rho + \delta\theta + 0.70 =$	1	$+0.40a + 1.17\rho + \delta\theta + 0.48 =$	1
$+0.58a - 1.87\rho + \delta\theta + 0.77 =$	1	$-0.04a + 1.35\rho + \delta\theta + 0.57 =$	1
$+0.71a - 1.78\rho + \delta\theta + 0.73 =$	1	$+0.74a + 1.49\rho + \delta\theta + 0.38 =$	1
$+0.94a - 1.53\rho + \delta\theta + 0.67 =$	1	$+0.64a + 1.82\rho + \delta\theta + 0.36 =$	1
$+0.72a - 1.37\rho + \delta\theta + 0.70 =$	1	$-0.26a + 1.93\rho + \delta\theta + 0.55 =$	0.67
$-0.11a - 1.24\rho + \delta\theta + 0.83 =$	0.74	$-0.21a + 2.05\rho + \delta\theta + 0.48 =$	0.60
$+0.38a - 1.09\rho + \delta\theta + 0.67 =$	1	$-0.06a + 2.17\rho + \delta\theta + 0.42 =$	1
$-0.01a - 1.00\rho + \delta\theta + 0.69 =$	1	$+0.56a + 2.24\rho + \delta\theta + 0.26 =$	1
$+0.07a - 0.86\rho + \delta\theta + 0.64 =$	1	$+0.59a + 2.32\rho + \delta\theta + 0.28 =$	1
$-4.74a - 0.58\rho + \delta\theta + 1.37 =$	0.052	$-2.63a + 2.69\rho + \delta\theta + 1.01 =$	0.115

Normal equations.

$$
\begin{aligned}
[+11.06]a &- 3.18\rho + 6.17\,\delta\theta + 2.86 = 0 \\
-3.18a &+ [+63.00]\rho - 0.56\,\delta\theta - 5.91 = 0 \\
+6.17a &- 0.56\rho + [+21.87]\,\delta\theta + 12.90 = 0
\end{aligned}
$$

Results.

$$
\begin{aligned}
& \quad\ \ s. \\
\delta\theta &= -0.619 \\
\rho &= +0.094 \\
a &= +0.113
\end{aligned}
$$

TABLE 23.—*Time determination, Ann Arbor, Mich., July 15, 1893.*

[Prof. Asaph Hall, jr., observer.]

Star.	Vision.	Number of wires.	b.	Bb	C. (c. + abn.).	Aa.	Rρ.	Chron. time of transit = t.	Right ascension = α.	Chron. correction Δ t.	$\sqrt{p}$ v (co. — ob.).
			s.	s.	s.	s.	s.	h. m. s.	h. m. s.	s.	s.
β Urs. Min	Dir.	11	+0.03	+0.08	—0.61	—0.06	—0.34	14 51 42.08	14 51 04.27	—36.68	+.01
β Libræ	D	11	+0.02	+0.03	—0.17	+0.03	—0.30	15 11 54.06	15 11 16.79	—36.85	00
γ² Urs. Min	D	11	+0.02	+0.07	—0.54	—0.05	—0.28	15 21 34.65	15 20 57.26	—36.60	—.12
ν¹ Bootis..	D	11	+0.02	0.03	—0.22	0.00	—0.26	15 27 44.52	15 27 07.25	—36.82	—.02
γ Libræ	D	7	+0.02	0.01	—0.17	+0.03	—0.26	15 30 11.68	15 29 34.46	—36.83	—.02
α Serpentis......	D	11	+0.02	0.02	—0.16	+0.02	—0.24	15 39 39.07	15 39 01.68	—36.88	+.03
μ Serpentis	D	11	+0.02	0.02	—0.16	+0.02	—0.23	15 44 41.43	15 44 04.15	—36.93	+.08
β¹ Scorpii	D	11	+0.02	+0.01	—0.17	+0.03	—0.19	15 59 52.32	15 59 15.10	—36.90	+.05
δ Ophiuchi ..	D	11	0.02	+0.01	—0.16	+0.02	—0.17	16 09 23.61	16 08 46.42	—36.89	+.04
τ Herculis. ...	D	11	0.02	0.03	—0.24	0.00	—0.16	16 17 11.00	16 16 33.68	—36.96	+.09
β Herculis....	D	11	+0.02	+0.02	—0.18	+0.01	—0.14	16 26 16.52	16 25 39.34	—36.89	+.04
σ Herculis	D	11	+0.02	0.03	—0.22	0.00	—0.13	16 31 18.67	16 30 41.51	—36.84	—.01
η Herculis.....	D	11	+0.02	+0.02	—0.21	0.00	—0.11	16 39 53.08	16 39 15.96	—36.80	—.05
ε Urs. Min	Ref	5	—0.07	—0.38	—1.20	—0.15	—0.07	16 57 41.72	16 57 02.70	—37.22	+.09
ε Urs. Min	Dir	5	+0.07	+0.38	—1.20	—0.15	—0.07	16 57 40.95			
δ Urs. Min	Ref	4	—0.06	—0.71	—2.75	—0.38	+0.08	18 07 43.95	18 07 01.96	—38.21	+.13
δ Urs. Min ...	Dir	4	+0.06	+0.71	—2.75	—0.38	+0.08	18 07 42.53			
109 Herculis	D	11	0.01	0.01	—0.18	+0.01	+0.10	18 19 47.65	18 19 10.73	—36.86	+.01
χ Draconis ..	D	9	+0.01	0.02	—0.55	—0.05	+0.11	18 23 40.28	18 23 02.83	—37.08	+.11
α Lyræ ..	D	11	+0.01	+0.01	—0.21	0.00	+0.13	18 33 58.28	18 33 21.41	—36.80	—.05
110 Herculis	D	11	0.01	0.01	—0.17	+0.01	+0.15	18 41 42.66	18 41 05.83	—36.85	00
R Lyræ	D	11	+0.01	0.02	—0.23	0.00	+0.17	18 52 44.17	18 52 07.23	—36.90	+.05
λ Aquilæ	D	11	0.01	0.01	—0.16	+0.02	+0.19	19 01 13.67	19 00 36.89	—36.84	—.01
δ Aquilæ	D	11	+0.01	+0.01	—0.16	+0.02	+0.23	19 20 45.55	19 20 08.79	—36.86	+.01
ι Cygni.	D	11	0.01	+0.02	—0.26	—0.01	+0.25	19 27 39.82	19 27 03.07	—36.75	—.08
θ Cygni	D	11	0.0	0.02	—0.25	—0.01	+0.26	19 34 13.65	19 33 36.85	—36.82	—.03
δ Cygni	D	11	+0.01	+0.02	—0.23	0.00	+0.28	19 42 17.03	19 41 40.32	—36.78	—.07
α Aquilæ..	D	11	+0.01	+0.01	—0.17	+0.02	+0.28	19 46 12.99	19 45 36.30	—36.83	—.02
β Aquilæ	D	11	+0.01	0.01	—0.16	+0.02	+0.29	19 50 42.62	19 50 05.97	—36.81	—.04
γ Cephei	Ref	5	—0.10	—0.35	—0.75	—0.06	+0.34	20 13 11.27	20 12 33.07	—37.96	+.18
γ Cephei	Dir.	4	+0.10	+0.35	—0.75	—0.06	+0.34	20 13 10.56			

Chronometer correction at 17.5 hours: Chronometer time, —36s.854, hourly rate, +0s.127, azimuth, +0s.032.

Collimation = c.

	s.
	—0.172
	—0.122
Mean	—0.147

TABLE 24.—*Observation equations, Ann Arbor, Mich., July 15, 1893.*

[Epoch, 17.5 hours, chronometer time. $\Delta t = -36.00 + \delta\theta$.]

	p.		p.
$-2.01a - 2.68\rho + \delta\theta + 1.28 = v$	0.19	$-11.82a + 0.60\rho + \delta\theta + 2.51 = v$	0.009
$+0.79a - 2.33\rho + \delta\theta + 1.12 =$	1	$+0.38a + 0.80\rho + \delta\theta + 0.75 =$	1
$-1.03a - 2.18\rho + \delta\theta + 0.93 =$	0.24	$-1.70a + 0.87\rho + \delta\theta + 0.92 =$	0.223
$+0.02a - 2.06\rho + \delta\theta + 1.08 =$	1	$+0.08a + 1.04\rho + \delta\theta + 0.67 =$	1
$+0.86a - 2.03\rho + \delta\theta + 1.06 =$	0.93	$+0.40a + 1.17\rho + \delta\theta + 0.69 =$	1
$+0.58a - 1.87\rho + \delta\theta + 1.10 =$	1	$-0.04a + 1.35\rho + \delta\theta + 0.73 =$	1
$+0.71a - 1.78\rho + \delta\theta + 1.14 =$	1	$+0.74a + 1.49\rho + \delta\theta + 0.63 =$	1
$+0.94a - 1.53\rho + \delta\theta + 1.06 =$	1	$+0.64a + 1.82\rho + \delta\theta + 0.61 =$	1
$+0.72a - 1.37\rho + \delta\theta + 1.04 =$	1	$-0.26a + 1.93\rho + \delta\theta + 0.51 =$	0.67
$-0.11a - 1.24\rho + \delta\theta + 1.11 =$	0.74	$-0.21a + 2.05\rho + \delta\theta + 0.57 =$	0.69
$+0.38a - 1.00\rho + \delta\theta + 1.02 =$	1	$-0.06a + 2.17\rho + \delta\theta + 0.50 =$	1
$-0.01a - 1.00\rho + \delta\theta + 0.97 =$	1	$+0.56a + 2.24\rho + \delta\theta + 0.53 =$	1
$+0.07a - 0.86\rho + \delta\theta + 0.91 =$	1	$+0.59a + 2.32\rho + \delta\theta + 0.50 =$	1
$-4.74a - 0.58\rho + \delta\theta + 1.44 =$	0.052	$-2.63a + 2.69\rho + \delta\theta + 1.10 =$	0.122

Normal equations.

$$[+11.02]a - 2.97\rho + 6.07\,\delta\theta + 5.20 = 0$$
$$-2.97a\ [+62.97]\rho - 0.13\,\delta\theta - 7.99 = 0$$
$$+6.07a - 0.13\rho\ [+21.86]\,\delta\theta + 18.48 = 0$$

Results.

$$\delta\theta = -0.854^{s}$$
$$\rho = -0.127$$
$$a = +0.032$$

TABLE 25.—*Time determination, Ann Arbor, Mich., July 19, 1893.*

[Prof. Asaph Hall, jr., observer.]

Star	Vision	Number of wires	*b*	*Bb*.	*C*. (c + abn.).	*Aa*	*Rp*.	Chronometer time of transit *t*.	Right ascension = *a*.	Chron. correction Δt.	$\sqrt{p}$ v (co. — ob.).
			s	*s*	*s*	*s*.	*s*.	*h. m. s.*	*h. m. s*	*s*	*s*.
ε Urs. Min.	Ref	4	0.12	0.68	—1.40	—0.20	—0.30	16 57 29.02	16 57 02.19	—24.25	+ 01
ε Urs. Min.	Dir	4	+0.12	+0.68	—1.40	—0.20	—0.30	16 57 27.66			
η Ophiuchi	D	10	+0.02	0.01	0.20	0.04	—0.28	17 04 41.61	17 04 16.68	—24.30	+.10
π Herculis	D	11	0.02	0.02	—0.24	+0.01	—0.27	17 11 46.19	17 11 21.52	24.19	.01
β Draconis	D	11	0.02	0.03	—0.31	—0.01	—0.23	17 28 28.07	17 28 03.43	—24.12	—.08
ξ Serpentis	D	11	0.02	0.01	—0.20	+0.04	—0.22	17 31 54.77	17 31 30.18	—24.22	+.02
ι Herculis	D	11	+0.02	0.02	—0.27	0.00	—0.21	17 36 53.77	17 36 29.13	—24.18	—.02
μ Herculis	D	11	+0.02	+0.02	—0.21	0.01	0.20	17 42 43.16	17 42 18.61	—24.15	.05
γ Draconis	D	11	+0.01	0.02	—0.31	—0.01	—0.17	17 54 34.45	17 54 09.61	—24.17	—.02
72 Ophiuchi	D	11	+0.01	0.01	—0.19	+0.02	0.15	18 02 43.56	18 02 19.04	—24.21	+.01
μ Sagittarii	D	11	+0.01	0.00	—0.20	0.04	—0.14	18 07 49.20	18 07 24.72	—24.18	—.02
η Serpentis	D	11	0.01	0.01	—0.19	+0.03	—0.12	18 16 13.49	18 15 48.92	—24.30	+.10
χ Draconis	D	11	0.01	+0.02	0.64	—0.07	0.10	18 23 27.63	18 23 02.70	—24.14	+.03
α Lyræ	D	9	0.00	0.00	—0.25	0.00	—0.08	18 33 45.85	18 33 21.40	—24.12	—.08
51 H Ceph. L. C	Ref.	4	0.07	0.90	3.91	0.68	0.04	18 50 22.36	6 50 05.20	—22.81	—.13
51 H Ceph. L. C	Dir	2	+0.07	—0.90	+3.91	+0.68	—0.04	18 50 24.16			
λ Urs Min.	Dir.	3	0.01	0.27	—10.60	—1.75	+0.05	19 31 27 05	19 30 52.40	—22.82	—.05
β Aquilæ	D	11	+0.01	+0.01	—0.19	+0.03	+0.09	19 50 30.32	19 50 06.01	—24.25	+ 05
θ Aquilæ	D	11	+0.01	0.01	—0.19	+0.03	+0.13	20 06 13.96	20 05 49.68	—24.28	+.08
o¹ Seq. Cygni	D	11	0.01	+0.02	—0.27	0.00	+0.14	20 10 42.51	20 10 18.19	—24.21	+ 01
α² Capricorni	D	6	+0.01	+0.01	0.20	+0.04	+0.14	20 12 34.13	20 12 09.93	—24.19	—.01
γ Cygni	D	11	+0.01	0.02	—0.25	0.00	+0.15	20 18 49.94	20 18 25.71	—24.15	.05
θ Cephei	D	11	0.01	+0.03	—0.41	—0.03	+0.18	20 28 14.38	20 27 49.81	24.34	+ 09
α Cygni	D	11	+0.01	0.02	—0.27	0.00	+0.20	20 38 13.05	20 37 49.44	—24.16	— 04
η Cephei	D	11	0.02	0.03	—0.40	—0.01	+0.21	20 43 33.81	20 43 09.36	24.26	+.04
32 Vulpeculæ	D	11	+0.02	+0.02	0.21	+0.01	+0.23	20 50 26.50	20 50 02.36	—24.19	— 01
ν Cygni	D	11	+0.02	+0.02	0.25	0.00	+0.23	20 53 37.56	20 53 13.38	—24.18	—.02
ν Aquarii	D	11	+0.02	+0.01	0.20	+0.04	+0.26	21 04 12.81	21 03 48.71	—24.21	+.01
α Equulei	D	11	+0.02	+0.02	—0.19	+0.03	0.27	21 10 55.07	21 10 30.90	—24.21	+.01
1 H. Drac. L. C	Ref.	5	—0.09	+0.37	+1.33	+0.25	+0.30	21 22 08.34	9 21 46.56	—24.01	—.04
1 H. Drac. L. C	Dir.	5	0.09	—0.37	1.33	+0.25	+0.30	21 22 09.06			

Chronometer correction at 19.2 hours. Chronometer time, — 24ˢ.201, hourly rate, + 0ˢ.135, azimuth, + 0ˢ.043.

Collimation = c.

	s.
	—0.216
	—0.131
Mean	—0.174

TABLE 26.—*Observation equations, Ann Arbor, Mich., July 19, 1893.*

[Epoch, 19.2 hours, chronometer time. $\Delta t = -24.00 + \delta\theta$.]

	p.		p.
$-4.74a - 2.22\rho + \delta\theta + 0.75 = v$	0.049	$-40.58a + 0.34\rho + \delta\theta + 0.32 = v$	0.0008
$+0.879a - 2.09\rho + \delta\theta + 0.54 =$	0.99	$+0.593a + 0.67\rho + \delta\theta + 0.13 =$	1
$+0.117a - 1.97\rho + \delta\theta + 0.45 =$	1	$+0.688a + 0.93\rho + \delta\theta + 0.12 =$	1
$-0.287a - 1.69\rho + \delta\theta + 0.36 =$	0.65	$+0.105a + 1.01\rho + \delta\theta + 0.07 =$	0.74
$+0.876a - 1.64\rho + \delta\theta + 0.40 =$	1	$+0.842a + 1.04\rho + \delta\theta + 0.01 =$	0.90
$-0.095a - 1.57\rho + \delta\theta + 0.39 =$	0.75	$+0.054a + 1.14\rho + \delta\theta - 0.00 =$	1
$+0.283a - 1.46\rho + \delta\theta + 0.36 =$	1	$-0.756a + 1.30\rho + \delta\theta + 0.19 =$	0.45
$-0.257a - 1.27\rho + \delta\theta + 0.35 =$	0.67	$-0.064a + 1.47\rho + \delta\theta - 0.04 =$	1
$+0.548a - 1.12\rho + \delta\theta + 0.34 =$	1	$-0.686a + 1.56\rho + \delta\theta + 0.08 =$	0.48
$+0.958a - 1.04\rho + \delta\theta + 0.28 =$	1	$+0.280a + 1.67\rho + \delta\theta - 0.05 =$	1
$+0.711a - 0.90\rho + \delta\theta + 0.39 =$	1	$+0.035a + 1.73\rho + \delta\theta - 0.05 =$	1
$-1.700a - 0.77\rho + \delta\theta + 0.31 =$	0.23	$+0.827a + 1.90\rho + \delta\theta - 0.09 =$	1
$+0.080a - 0.61\rho + \delta\theta + 0.20 =$	0.97	$+0.610a + 2.01\rho + \delta\theta - 0.09 =$	1
$+15.870a - 0.33\rho + \delta\theta - 2.03 =$	0.006	$+5.81a + 2.20\rho + \delta\theta - 0.54 =$	0.052

Normal equations.

$$
\begin{aligned}
[+11.70]a + 0.17\rho + 6.95\,\delta\theta + 0.91 &= 0 \\
+0.17a\ [+43.87]\rho + 0.40\,\delta\theta - 5.84 &= 0 \\
+6.95a + 0.40\rho\ [+20.94]\,\delta\theta + 3.88 &= 0
\end{aligned}
$$

Results.

$$
\begin{aligned}
& \quad \text{s.} \\
\delta\theta &= -0.201 \\
\rho &= +0.135 \\
a &= +0.043
\end{aligned}
$$

TABLE 27.—*Time determination, Ann Arbor, Mich., July 20, 1893.*

[Prof Asaph Hall, jr., observer.]

Star.	Vision.	Number of wires	*b*	*Bb.*	*C.* (c + abn)	*Aa*	*Rp.*	Chronometer time of transit —*t*.	Right ascension —*α*.	Chron. correction Δ*t*	$\sqrt{p}\,v$ (co.—ob.).
			s.	*s*	*s.*	*s.*	*s*	*h. m s.*	*h m. s*	*s*	*s.*
ε Urs. Min	Ref.	5	—0.11	-0.62	—1 51	—0.11	0.18	16 57 25.88	16 57 02.07	—21 39	+.05
ε Urs. Min	Dir.	5	+0.11	+0.62	—1.51	—0.11	—0.18	16 57 24.85	....	...	......
η Ophiuchi	D	11	+0.03	+0.01	—0.21	+0.02	0.17	17 04 38.47	17 04 16.96	—21.10	00
π Herculis .. .	D	11	+0.03	+0.04	—0.36	0.00	—0.16	17 11 43.07	17 11 21.51	—21 18	+ 02
β Draconis	D	11	+0.03	+0.05	—0.33	0.01	0.14	17 28 24.98	17 28 03.41	21 14	—.02
ξ Serpentis.. . .	D	11	+0 04	0.02	—0 21	+0.02	-0.13	17 31 51 60	17 31 30.18	—21.12	—.04
ι Herculis........	D	11	+0 04	0 06	—0.29	0.00	0.13	17 36 50.59	17 36 29.12	—21 11	— 04
μ Herculis	D	11	+0.04	0 04	—0.23	+0 01	0.12	17 42 40.03	17 42 18.61	—21 10	— 06
γ Draconis	D	11	+0 04	+0.07	—0.33	—0.01	0.10	17 54 31 32	17 54 09 80	—21 15	01
72 Ophiuchi	D	11	+0.05	+0.04	0.21	+0.01	—0.09	18 02 40.48	18 02 19.04	21 19	+.03
μ Sagittarii . ..	D	11	+0.05	+0 02	—0.22	+0.02	—0.08	18 07 46.10	18 07 24 72	—21 21	+ 05
η Serpentis.	D	11	0.05	0.04	—0.21	+0.02	—0.07	18 16 10.40	18 15 48.92	—21 26	+.10
χ Draconis.. ...	D	11	+0.05	+0.15	—0.69	—0.04	0.06	18 23 24.49	18 23 02.67	21 18	+.01
α Lyræ	D	11	+0.06	+0 07	0.26	0.00	—0.05	18 33 42.76	18 33 21 40	—21 12	—.04
51 H Ceph. L. C ..	Ref.	3	—0.18	+2.32	+4.20	+0.37	0.03	18 50 19.26	6 50 05.41	20.71	—.03
51 H Ceph. L. C.	Dir.	3	+0.18	—2.32	+4.20	+0.37	—0.03	18 50 23.90	....	....	......
β Aquilæ..........	D	11	+0.07	+0.05	0 21	+0.01	+0.05	19 50 27 32	19 50 06 02	21.20	+ 04
θ Aquilæ	D	11	+0 07	+0.05	—0.20	+0.02	+0.07	20 06 10.94	20 05 49.00	—21.39	+ 03
O¹ Seq. Cygni ...	D	11	+0.07	+0.10	—0.29	0 00	+0.08	20 10 39 47	20 10 18.29	—21.16	.00
α² Capricorni. ...	D	7	+0 07	+0.04	—0.21	+0.02	+0.08	20 12 31 18	20 12 09.94	21.17	+.01
γ Cygni	D	11	+0 07	+0.09	0.27	0.00	+0.09	20 18 47.00	20 18 25.72	21.19	.03
θ Cephei..........	D	11	+0.07	+0.14	—0.44	—0.02	+0.10	20 28 11.25	20 27 49.82	—21.21	+.03
α Cygni	D	11	+0.07	+0.10	0.29	0 00	+0.12	20 38 10.72	20 37 49.45	—21 20	+ 04
η Cephei	D	11	+0.07	+0.14	—0.43	—0.02	+0.13	20 43 30.77	20 43 09 37	—21 12	.03
32 Vulpeculæ	D	11	+0.07	+0.08	—0.23	+0 01	+0.13	20 50 23.52	20 50 02.37	—21 14	— 02
ν Cygni	D	11	+0.07	+0.09	0.27	0.00	+0.14	20 53 34.58	20 53 13.39	—21.15	—01
ν Aquarii	D	11	+0.07	+0.04	0.21	+0.02	+0.15	21 04 09 79	21 03 48.73	—21.06	.10
α Equulei	D	11	+0.07	+0.06	0.21	+0.01	+0.16	21 10 52.12	21 10 31.01	21 13	—.03
1 H. Drac. L. C ..	Ref.	4	0.21	+0 81	+1.43	+0.13	+0.18	21 23 05.58	9 21 40.56	—21.57	+.09
1 H. Drac. L. C .	Dir.	5	+0.21	—0.81	+1.43	+0.13	+0.18	21 22 07.20	....	....	.....

Chronometer correction at 19.2 hours: Chronometer time, —21.165; hourly rate, +0.080; azimuth, +0.023.

Collimation = *o.*

	s.
	0.178
	—0.197
Mean	—0.188

TABLE 28.—*Observation equations, Ann Arbor, Mich., July 20, 1893.*

[Epoch. 19.2 hours chronometer time. $\Delta t = -21.00 + \delta\theta$.]

	p		p
$-4.74a - 2.22\rho + \delta\theta + 0.68 = v$	0.052	$+0.593a + 0.67\rho + \delta\theta + 0.14 = v$	1
		$+0.688a + 0.93\rho + \delta\theta + 0.10 =$	1
$+0.879a - 2.09\rho + \delta\theta + 0.31 =$	1	$+0.105a + 1.01\rho + \delta\theta + 0.08 =$	0.74
$+0.117a - 1.97\rho + \delta\theta + 0.34 =$	1	$+0.842a + 1.04\rho + \delta\theta + 0.07 =$	0.93
$-0.287a - 1.69\rho - \delta\theta + 0.29 =$	0.65	$+0.054a + 1.14\rho + \delta\theta + 0.10 =$	1
$+0.876a - 1.64\rho - \delta\theta + 0.23 =$	1	$-0.756a + 1.30\rho + \delta\theta + 0.13 =$	0.45
$-0.095a - 1.57\rho + \delta\theta + 0.24 =$	0.75		
$+0.283a - 1.46\rho + \delta\theta + 0.21 =$	1	$-0.064a + 1.47\rho + \delta\theta + 0.08 =$	1
		$-0.686a + 1.56\rho + \delta\theta + 0.11 =$	0.48
$-0.257a - 1.27\rho + \delta\theta + 0.26 =$	0.67	$+0.286a + 1.67\rho + \delta\theta \quad 0.00 =$	1
$+0.548a - 1.12\rho + \delta\theta + 0.27 =$	1	$+0.035a + 1.73\rho + \delta\theta + 0.01 =$	1
$+0.958a - 1.04\rho + \delta\theta + 0.27 =$	1	$+0.827a + 1.90\rho + \delta\theta - 0.11 =$	1
$+0.711a - 0.90\rho + \delta\theta + 0.31 =$	1	$+0.610a + 2.01\rho + \delta\theta - 0.04 =$	1
$-1.700a - 0.77\rho + \delta\theta + 0.28 =$	0.23		
$+0.080a - 0.61\rho + \delta\theta + 0.17 =$	1	$+5.81a + 2.20\rho + \delta\theta + 0.26 =$	0.052
$+15.87a - 0.33\rho + \delta\theta - 0.63 =$	0.005		

Normal equations.

$$[+11.41]a + 0.23\rho + 6.98\,\delta\theta + 0.87 = 0$$
$$+0.23\,a + [+43.97]\rho + 0.38\,\delta\theta - 3.48 = 0$$
$$+6.98\,a + 0.38\,\rho + [+21.01]\,\delta\theta + 3.27 = 0$$

Results.

$$\begin{aligned} & \quad s. \\ \delta\theta &= -0.165 \\ \rho &= +0.080 \\ a &= +0.023 \end{aligned}$$

TABLE 29.—*Time determination, Ann Arbor, Mich., July 26, 1893.*

[Prof. Asaph Hall, jr., observer.]

Star.	Vision.	Number of wires.	*b*.	*Bb*.	*C*. (c. + abn.).	*Aa*.	*Rρ*.	Chronometer time of transit = *t*.	Right ascension = *α*.	Chron. correction. Δt.	$\sqrt{p}\,v$ (co.—ob.).
			s.	*s.*	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*
ε Urs. Min.	Ref.	3	0.00	0.00	−1.49	+3.90	−0.30	16 57 02.83	16 57 01.23	−3.71	−.20
ε Urs. Min.	Dir.	2	0.00	0.00	−1.49	+3.90	−0.30	16 57 02.83	....	......	.....
η Ophiuchi	D	11	+0.03	+0.02	−0.21	−0.72	−0.28	17 04 22.79	17 04 16.93	−4.67	+.03
π Herculis	D	11	+0.04	+0.04	−0.25	−0.10	−0.26	17 11 26.63	17 11 21.43	−4.63	−.01
β Draconis	D	11	+0.04	+0.06	−0.33	+0.24	−0.22	17 28 08.09	17 28 03.30	−4.54	−.08
ξ Serpentis	D	11	+0.04	+0.02	−0.21	−0.72	−0.22	17 31 35.96	17 31 30.16	−4.67	+.03
ι Herculis	D	11	+0.04	+0.05	−0.29	+0.08	−0.21	17 36 33.92	17 36 29.03	−4.52	−.10
μ Herculis	D	11	+0.04	+0.04	−0.23	−0.23	−0.19	17 42 23.74	17 42 18.56	−4.57	−.07
γ Draconis	D	8	+0.04	+0.06	−0.33	+0.21	−0.17	17 54 14.49	17 54 09.70	−4.56	−.06
72 Ophiuchi	D	11	+0.04	+0.03	−0.21	−0.45	−0.15	18 02 24.45	18 02 19.02	−4.65	+.01
μ Sagittarii	D	11	+0.04	+0.02	−0.22	−0.79	−0.14	18 07 30.46	18 07 24.72	−4.61	−.03
η Serpentis	D	11	+0.04	+0.03	−0.20	−0.58	−0.12	18 15 54.61	18 15 48.92	−4.82	+.18
χ Draconis	D	11	+0.04	+0.12	−0.68	+1.40	−0.10	18 23 06.33	18 23 02.44	−4.63	.00
α Lyræ	D	11	+0.04	+0.05	−0.26	−0.07	−0.08	18 33 26.38	18 33 21.34	−4.68	+.04
51 H. Ceph. L. C.	D	5	+0.04	−0.58	+4.16	−13.07	−0.04	18 50 16.66	6 50 07.09	−0.04	−.37
β Aquilæ	D	11	+0.05	+0.04	−0.20	−0.49	+0.09	19 50 11.33	19 50 06.06	−4.72	+.08
θ Aquilæ	D	11	+0.05	+0.03	−0.20	−0.57	+0.12	20 05 55.03	20 05 49.75	−4.66	+.02
o¹ Seq. Cygni	D	8	+0.05	+0.07	−0.29	−0.09	+0.13	20 10 22.82	20 10 18.22	−4.42	−.18
γ Cygni	D	11	+0.05	+0.06	−0.26	−0.04	+0.15	20 18 30.41	20 18 25.76	−4.56	−.08
θ Cephei	D	11	+0.05	+0.10	−0.44	+0.62	+0.17	20 27 54.07	20 27 49.84	−4.68	+.03
α Cygni	D	6	+0.05	+0.07	−0.28	+0.05	+0.20	20 37 54.12	20 37 49.51	−4.65	+.01
η Cephei	D	11	+0.05	+0.10	−0.42	+0.56	+0.21	20 43 13.74	20 43 09.42	−4.77	+.09
32 Vulpeculæ	D	11	+0.05	+0.05	−0.23	−0.24	+0.22	20 50 07.25	20 50 02.44	−4.61	−.03
ν Cygni	D	11	+0.05	+0.06	−0.27	−0.03	+0.23	20 53 18.15	20 53 13.46	−4.68	+.04
ν Aquarii	D	11	+0.05	+0.03	−0.21	−0.68	+0.25	21 03 54.08	21 03 48.82	−4.65	+.01
α Equulei	D	11	+0.05	+0.04	−0.20	−0.50	+0.27	21 10 36.17	21 10 31.10	−4.68	+.04
1 H. Drac. L. C.	Ref.	5	0.00	0.00	+1.42	−4.78	+0.29	21 21 55.12	9 21 46.51	−5.54	+.21
1 H. Drac. L. C.	Dir.	5	0.00	0.00	+1.42	−4.78	+0.29	21 21 55.13	....	....	.....

Chronometer correction at 19.2 hours: Chronometer time, —4.643; hourly rate, + 0.133; azimuth, —0.822.

Collimation = c.

	s.
	— 0.194
	— 0.178
Mean	— 0.186

TABLE 30.—*Observation equations, Ann Arbor, Mich., July 26, 1893.*

[Epoch, 19.2 hours, clock time, $\Delta t = -4^{s}.00 + \delta\theta$.]

	p
$-4.74\,a - 2.22\rho + \delta\theta - 3.89 = v$	0.045
$+0.879a - 2.09\rho + \delta\theta + 1.67 =$	1
$+0.117a - 1.97\rho + \delta\theta + 0.99 =$	1
$-0.287a - 1.69\rho + \delta\theta + 0.52 =$	0.65
$+0.876a - 1.64\rho + \delta\theta + 1.61 =$	1
$-0.095a - 1.57\rho + \delta\theta + 0.65 =$	0.75
$+0.283a - 1.46\rho + \delta\theta + 0.99 =$	1
$-0.257a - 1.27\rho + \delta\theta + 0.52 =$	0.64
$+0.548a - 1.12\rho + \delta\theta + 1.25 =$	1.
$+0.958a - 1.04\rho + \delta\theta + 1.54 =$	1.
$+0.711a - 0.90\rho + \delta\theta + 1.52 =$	1.
$-1.700a - 0.77\rho + \delta\theta - 0.67 =$	0.23
$+0.080a - 0.61\rho + \delta\theta + 0.83 =$	1.
$+15.87\,a - 0.33\rho + \delta\theta + 9.15 =$	0.006

	p
$+0.593a + 0.67\rho + \delta\theta + 1.11 = v$	1
$+0.688a + 0.93\rho + \delta\theta + 1.11 =$	1
$+0.105a + 1.01\rho + \delta\theta + 0.38 =$	0.70
$+0.054a + 1.14\rho + \delta\theta + 0.45 =$	1
$-0.756a + 1.30\rho + \delta\theta - 0.11 =$	0.45
$-0.064a + 1.47\rho + \delta\theta + 0.40 =$	0.90
$-0.680a + 1.56\rho + \delta\theta - 0.00 =$	0.48
$+0.286a + 1.67\rho + \delta\theta + 0.63 =$	1.
$+0.035a + 1.73\rho + \delta\theta + 0.48 =$	1.
$+0.827a + 1.90\rho + \delta\theta + 1.08 =$	1.
$+0.610a + 2.01\rho + \delta\theta + 0.91 =$	1.
$+5.81\,a + 2.20\rho + \delta\theta + 6.08 =$	0.053

Normal equations.

$$
\begin{aligned}
[+9.32]a - 0.70\,\rho + 6.17\,\delta\theta + 11.72 &= 0 \\
-0.70\,a\,[+42.62]\rho - 0.72\,\delta\theta - 6.70 &= 0 \\
+6.17\,a - 0.72\,\rho\,[+19.90]\,\delta\theta + 17.97 &= 0
\end{aligned}
$$

Results.

$$
\begin{aligned}
& \quad\ \ s. \\
\delta\theta &= -0.643 \\
\rho &= +0.133 \\
a &= -0.822
\end{aligned}
$$

TABLE 31.—*Time determination, Ann Arbor, Mich., August 6, 1893.*

[First Lieut. Charles S. Riché, observer.]

Star.	Vision	Number of wires	b	Bb	C (c. + abn.).	Aa.	Rρ	Chronometer time of transit = t.	Right ascension = α	Chron. correction Δt.	√p v (co. — ob.)
			s.	s	s	s	s	h m s	h m s	s	s.
ε Urs. Min	Ref.	4	—0.09	—0.49	—1 23	4.82	0.08	16 56 34.56	16 56 59.56	+21.98	+ 03
ε Urs. Min	Dir.	4	+0.09	+0.40	—1 23	+4.82	0.08	16 50 33.58	....	....	......
η Ophiuchi	D	11	+0.08	+0.08	—0 17	—0.89	0 08	17 03 55.92	17 04 16.84	+22 03	06
π Herculis	D	11	+0 06	+0.07	0.21	0 12	0.07	17 10 59.53	17 11 21.27	+22.07	+.02
β Draconis	D	11	+0.05	+0.08	—0.27	+0.29	0.08	17 27 40.84	17 28 03.05	+22 17	06
ξ Serpentis.	D	11	+0.05	0.03	—0.17	—0.60	—0.06	17 31 09.16	17 31 30.10	+22.03	+ 06
ι Herculis.	D	11	+0.05	+0.07	—0.24	+0.10	0.06	17 36 06.87	17 36 28 84	22 10	— 01
μ Herculis	D	11	+0.06	+0.06	—0.19	—0.29	—0.05	17 41 56.77	17 42 18.45	+22.16	.07
γ Draconis ...	D	11	+0.04	+0.07	0 27	+0.26	0.05	17 53 47 33	17 54 09.49	22.15	05
72 Ophiuchi	D	11	0.04	+0 03	0 17	0 56	—0.04	18 01 57 61	18 02 18 96	+22.09	00
μ Sagittarii	D	11	+0 04	0 02	—0.18	0 97	—0 04	18 07 03.73	18 07 24.69	+22.13	+.04
η Serpentis.	D	11	+0.04	+0.03	0 17	—0.72	0.03	18 15 27 66	18 15 48.88	+22.11	02
χ Draconis	D	11	+0 03	+0 09	—0.56	+1 73	—0 03	18 22 38.78	18 23 01.92	+21 91	09
α Lyræ	D	11	+0.03	+0.04	—0.21	—0.08	—0.02	18 32 59.46	18 33 21.26	+22.07	+.02
51 H Ceph. L. C ..	Ref.	3	0 01	0 07	3 42	—16.14	—0.01	18 50 00.09	6 50 10.65	+23 36	.10
β Aquilæ .. .	D	11	+0.07	+0.06	—0.17	—0.60	+0 01	19 49 44 72	19 50 06.11	22.09	.00
θ Aquilæ	D	11	+0.08	+0.06	0 17	—0.70	+0.02	20 05 28.50	20 05 49.81	22.10	01
o¹ Seq. Cygni .	D	11	+0.08	+0.12	0.24	0.11	+0 03	20 09 56 05	20 10 18.23	22 38	—.25
α² Capricorni ...	D	3	+0.08	+0 05	0 17	0.66	+0.04	20 11 48.93	20 12 10.09	+22.10	—.01
γ Cygni	D	11	+0.09	0 10	—0.22	—0.05	+0.04	20 18 03 75	20 18 25 79	+22 17	08
θ Cephei..........	D	11	+0.09	+0.19	0 36	+0.77	+0 04	20 27 27 47	20 27 49.82	+21 81	+.19
α Cygni...........	D	11	+0.10	0.14	0.23	+0 07	+0.05	20 37 27 51	20 37 49 56	22.02	+.07
η Cephei	D	11	+0 10	+0.21	0.35	+0.70	+0.06	20 42 47 01	20 43 09.44	21 81	+ 20
32 Vulpeculæ ..	D	11	+0.11	0.12	0.19	0.29	+0.06	20 49 40 72	20 50 02.53	+22.11	— 02
ν Cygni	D	11	+0.11	0.14	—0.22	—0.04	0.06	20 52 51 57	20 53 13.54	+22 07	.02
ν Aquarii	D	11	+0 12	+0.07	0.17	0.84	+0 07	21 03 27 65	21 03 48.05	+22.17	—.08
α Equulei	D	11	+0.12	0.10	0.17	0 62	+0.07	21 10 09.77	21 10 31.23	22.08	+.01
1 H. Drac. L. C .	Ref	3	0.20	0 77	+1.16	5.91	+0.08	21 21 28.14	9 21 46.64	+22.40	—.07
1 H. Drac L. C.	Dir.	4	0.20	—0 77	+1.16	—5.91	+0.08	21 21 29 69	....		...

Chronometer correction at 19.2 hours. Chronometer time, + 22.093, hourly rate, + 0.036, azimuth, —1.017.

Collimation = c.

s.
—0.123
—0.200
—0.126
Mean—0.150

TABLE 32.—*Observation equations, Ann Arbor, Mich., August 6, 1893.*

[Epoch, 19.2, chronometer time. $\Delta t = +22.00 + \delta\theta$.]

	p
$-4.74\,a - 2.22\rho + \delta\theta - 4.72 = v$	0.049
$+0.879a - 2.09\rho + \delta\theta - 0.94 =$	1
$+0.117a - 1.97\rho + \delta\theta + 0.12 =$	1
$-0.287a - 1.69\rho + \delta\theta - 0.40 =$	0.65
$+0.876a - 1.64\rho + \delta\theta + 0.92 =$	1
$-0.095a - 1.57\rho + \delta\theta - 0.14 =$	0.75
$+0.283a - 1.46\rho + \delta\theta + 0.18 =$	1
$-0.257a - 1.27\rho + \delta\theta - 0.36 =$	0.67
$+0.548a - 1.12\rho + \delta\theta + 0.51 =$	1
$+0.958a - 1.04\rho + \delta\theta + 0.88 =$	1
$+0.711a - 0.90\rho + \delta\theta + 0.64 =$	1
$-1.700a - 0.77\rho + \delta\theta - 1.61 =$	0.23
$+0.080a - 0.61\rho + \delta\theta + 0.03 =$	1
$+15.87\,a - 0.33\rho + \delta\theta + 14.79 =$	0.006

	p
$+0.593a + 0.67\rho + \delta\theta + 0.50 = v$	1
$+0.688a + 0.93\rho + \delta\theta + 0.58 =$	1
$+0.105a + 1.01\rho + \delta\theta - 0.30 =$	0.74
$+0.842a + 1.04\rho + \delta\theta + 0.72 =$	0.75
$+0.054a + 1.14\rho + \delta\theta - 0.16 =$	1
$-0.756a + 1.30\rho + \delta\theta - 0.62 =$	0.45
$-0.064a + 1.47\rho + \delta\theta - 0.14 =$	1
$-0.686a + 1.56\rho + \delta\theta - 0.57 =$	0.48
$+0.286a + 1.67\rho + \delta\theta + 0.12 =$	1
$+0.035a + 1.73\rho + \delta\theta - 0.09 =$	1
$+0.827a + 1.90\rho + \delta\theta + 0.60 =$	1
$+0.610a + 2.01\rho + \delta\theta + 0.47 =$	1
$+5.81\,a + 2.20\rho + \delta\theta + 5.43 =$	0.049

Normal equations.

$$
\begin{aligned}
[+11.37]a &- 0.02\,\rho + 6.85\,\delta\theta + 10.93 = 0 \\
-0.02\,a &+ [+43.68]\rho + 0.24\,\delta\theta - 1.62 = 0 \\
+6.85\,a &+ 0.24\,\rho + [+20.82]\delta\theta + 5.02 = 0
\end{aligned}
$$

Results.

$$
\begin{aligned}
&\quad\ \ \mathrm{s.} \\
\delta\theta &= +0.093 \\
\rho &= +0.036 \\
a &= -1.017
\end{aligned}
$$

TABLE 33.—*Time determination, Ann Arbor, Mich., August 7, 1893.*

[First Lieut. Charles S. Riché, observer.]

Star.	Vision.	Number of wires.	b.	Bb	C. (c.+abn.).	Aa.	$R\rho$.	Chronometer time of transit=t.	Right ascension=α.	Chron. correction Δt.	$\sqrt{p}\,v$ (co.—ob.).
			s.	*s.*	*s.*	*s*	*s.*	*h. m s*	*h m s.*	*s*	*s*
ε Urs. Min ...	Ref	4	—0.03	—0.18	1.14	+4.65	—0.15	16 56 32.00	16 56 59.40	+24.22	—.05
ε Urs. Min	Dir.	4	+0.03	+0.18	—1.14	+4.65	—0.15	16 56 31.63	....	......	.....
η Ophiuchi	D	11	+0.02	+0.01	—0.16	—0.86	0.14	17 03 54.04	17 04 16.83	+23.94	+.04
π Herculis.	D	11	+0.02	+0.03	0.19	—0.11	—0.14	17 10 57.63	17 11 21 25	+24.03	.05
β Draconis	D	11	+0.03	+0.04	0 25	+0.28	0.12	17 27 38.92	17 28 03.02	+24.15	—.14
ξ Serpentis	D	9	+0.03	+0.01	0.16	0.88	—0.11	17 31 07.29	17 31 30.09	+23.92	+.06
ι Herculis	D	11	+0.03	+0.04	—0.22	+0.09	—0.11	17 36 04.96	17 36 28.83	+24.07	—.08
μ Herculis	D	11	+0.03	+0.03	—0.18	—0.28	—0.10	17 41 54.88	17 42 18.44	+24.09	—.11
γ Draconis	D	10	+0.03	+0.05	—0.25	+0.25	—0.09	17 53 45.47	17 54 09.47	+24.04	—.05
72 Ophiuchi	D	11	+0.03	+0.03	—0.16	0.54	0.06	18 01 55.72	18 02 18.96	+23.99	—.01
μ Sagittarii	D	11	+0.03	+0.02	0.17	—0.94	—0.07	18 07 01.62	18 07 24.69	+24.03	—.05
η Serpentis	D	11	+0.03	+0.02	—0.16	—0.70	—0.06	18 15 25.81	18 15 48.88	+23.97	+.01
χ Draconis	D	11	+0.03	+0.10	—0.52	+1 67	—0.05	18 22 36.67	18 23 01.86	+24.01	—.01
α Lyræ	D	11	+0.04	+0.05	—0.20	0.08	0.04	18 32 57.50	18 33 21.25	+24.02	—.04
51 H. Cephei L. C..	Ref	3	—0.04	+0.53	+3.19	15.60	0.02	18 49 59.27	6 50 11.07	+23.70	+0.02
51 H Cephei L. C .	Dir.	3	+0.04	—0.53	+3.19	—15 60	—0.02	18 50 00.84	....	......	......
β Aquilæ	D	11	+0.04	+0.03	—0.16	—0.58	+0.02	19 49 42.84	19 50 06.11	+23.96	+0.2
θ Aquilæ	D	11	+0.04	+0.03	—0.16	—0.67	+0.05	20 05 26.61	20 05 49.81	+23.95	+0.3
o¹ Seq. Cygni	D	8	+0.04	+0.06	0.22	—0.10	+0.06	20 09 54.19	20 10 18.23	+24.24	—.23
α² Capricorni ..	D	3	+0.04	+0.02	—0.16	0.83	+0.07	20 11 46.85	20 12 10.12	+24.17	—.17
γ Cygni	D	11	+0.04	+0.05	—0.20	—0.05	+0.08	20 18 01 89	20 18 25.79	+24.02	.04
θ Cephei	D	11	+0.04	+0.07	—0.34	+0.74	+0.09	20 27 25.18	20 27 49.81	+24.07	—.08
α Cygni	D	11	+0.04	+0.05	—0.22	+0.06	+0.10	20 37 25.56	20 37 49.56	+24.01	—.03
η Cephei	D	11	+0.04	+0.07	0.33	+0.67	0.11	20 42 44.98	20 43 08.43	+23.93	+.03
32 Vulpeculæ......	D	11	0.04	0.04	—0.17	0.28	+0.12	20 49 38.79	20 50 02.54	+24.04	—.06
ν Cygni	D	11	+0.04	+0.06	—0.20	—0.03	+0.12	20 52 49.62	20 53 13.55	+23.99	—.01
ν Aquarii.........	D	11	+0.03	+0.02	0.16	0.81	+0.13	21 03 25.78	21 03 48.97	+24.01	—.03
α Equulei.........	D	11	+0.03	+0.03	—0.16	0.60	+0.14	21 10 07 86	21 10 31.25	+23.98	—.00
1 H. Draconis L.C.	Ref	4	—0.03	0.10	1.09	—5.70	+0.15	21 21 27.37	9 21 46.68	+23.67	+.07
1 H. Draconis L.C	Dir.	5	+0.03	—0.10	+1.09	5.70	+0.15	21 21 27 57	....	......	......

Chronometer correction at 19 2 hours: Chronometer time, +23.963, hourly rate, +0.069, azimuth, —0.981.

Collimation = c.

s.
—0.156
—0.149
—0.111
Mean, —0.139

TABLE 34.—*Observation equations, Ann Arbor, Mich., August 7, 1893.*

[Epoch, 19.2 hours, chronometer time. $\Delta t = +24.00 + \delta\theta$.]

Equation	p
$-4.74\,a - 2.22\rho + \delta\theta - 4.72 = v$	0.049
$+0.879a - 2.09\rho + \delta\theta + 1.06 =$	1
$+0.117a - 1.97\rho + \delta\theta + 0.22 =$	1
$-0.287a - 1.69\rho + \delta\theta - 0.31 =$	0.65
$+0.876a - 1.64\rho + \delta\theta + 1.05 =$	0.97
$-0.695a - 1.57\rho + \delta\theta - 0.05 =$	0.75
$+0.283a - 1.46\rho + \delta\theta + 0.29 =$	1
$-0.257a - 1.27\rho + \delta\theta - 0.20 =$	0.66
$+0.548a - 1.12\rho + \delta\theta + 0.63 =$	1
$+0.958a - 1.04\rho + \delta\theta + 0.98 =$	1
$+0.711a - 0.90\rho + \delta\theta + 0.79 =$	1
$-1.700a - 0.77\rho + \delta\theta - 1.63 =$	0.23
$+0.080a - 0.61\rho + \delta\theta + 0.10 =$	1
$+15.87\,a - 0.33\rho + \delta\theta + 15.92 =$	0.005

Equation	p
$+0.593a + 0.67\rho + \delta\theta + 0.60 = v$	1
$+0.688a + 0.93\rho + \delta\theta + 0.67 =$	1
$+0.105a + 1.01\rho + \delta\theta - 0.20 =$	0.71
$+0.842a + 1.04\rho + \delta\theta + 0.59 =$	0.75
$+0.054a + 1.14\rho + \delta\theta - 0.05 =$	1
$-0.756a + 1.30\rho + \delta\theta - 0.90 =$	0.45
$-0.064a + 1.47\rho + \delta\theta - 0.17 =$	1
$-0.686a + 1.56\rho + \delta\theta - 0.71 =$	0.48
$+0.286a + 1.67\rho + \delta\theta + 0.12 =$	1
$+0.035a + 1.73\rho + \delta\theta - 0.08 =$	1
$+0.827a + 1.90\rho + \delta\theta + 0.67 =$	1
$+0.610a + 2.01\rho + \delta\theta + 0.48 =$	1
$+5.81\,a + 2.20\rho + \delta\theta + 5.88 =$	0.052

Normal equations.

$$[+11.37]a + 0.06\rho + 6.82\,\delta\theta + 11.27 = 0$$
$$+0.06\,a\,[+43.56]\rho + 0.27\,\delta\theta - 2.95 = 0$$
$$+6.82\,a + 0.27\rho\,[+20.76]\,\delta\theta + 7.08 = 0$$

Results.

	s.
$\delta\theta =$	-0.017
$\rho =$	$+0.069$
$a =$	-0.961

TABLE 35.—*Time determination, Ann Arbor, Mich., August 8, 1893.*

[First Lieut. Charles S. Riché, observer.]

Star.	Vision	Number of wires.	b.	Bb.	C. (c. + abn.)	Aa.	Rp.	Chronometer time of transit = t.	Right ascension = α	Chron. correction Δ t.	√pv (co — ob.).
			s.	*s.*	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*
ε Urs. Min. ..	Ref.	4	—0.15	—0.84	—1.01	+4.92	—0.26	16 56 30.63	16 56 59.26	+25.82	+.06
ε Urs. Min.	Dir	4	+0.15	+0.84	—1.01	+4.92	—0.26	16 56 28.96	....	......	......
η Ophiuchi	D	11	+0.06	+0.03	—0.14	—0.91	—0.25	17 03 52.02	17 04 16.63	+26.07	+.03
π Herculis	D	11	+0.06	0.07	—0.17	—0.12	—0.23	17 10 55.62	17 11 21.24	+26.07	+.03
β Draconis	D	11	0.06	+0.09	—0.22	+0.30	—0.20	17 27 36.92	17 28 03.01	+26.12	—.02
ξ Serpentis	D	11	+0.06	+0.03	—0.14	—0.91	—0.19	17 31 05.24	17 31 30.06	+26.05	+.05
ι Herculis	D	11	+0.05	+0.08	—0.20	+0.10	—0.19	17 36 02.81	17 36 28.80	+26.20	—.09
μ Herculis	D	11	0.05	+0.06	—0.15	—0.29	—0.17	17 41 52.93	17 42 18.43	+26.15	.05
γ Draconis	D	11	+0.05	+0.08	—0.22	+0.27	—0.15	17 53 43.40	17 54 09.44	+26.06	+.03
72 Ophiuchi	D	11	+0.05	0.04	—0.14	0.57	—0.13	18 01 53.66	18 02 18.95	+26.09	+.01
μ Sagittarii	D	11	0.05	+0.02	—0.15	—1.00	—0.12	18 06 59.77	18 07 24.68	+26.16	—.06
η Serpentis	D	11	+0.05	0.03	—0.14	—0.74	—0.11	18 15 23.78	18 15 48.87	+26.05	+.05
χ Draconis	D	11	0.04	+0.13	—0.46	+1.77	0.09	18 22 34.51	18 23 01.82	+25.96	+.07
α Lyræ	D	11	+0.04	+0.06	—0.18	—0.08	—0.07	18 32 55.41	18 33 21.24	+26.10	.00
51 H Ceph. L. C	Ref.	3	—0.09	—1.23	+2.82	—16.49	0.04	18 49 57.04	6 50 11.50	+26.94	—.07
51 H Ceph. L. C	Dir	4	+0.09	+1.23	+2.82	—16.49	—0.04	18 49 59.50	....	......	......
β Aquilæ	D	11	+0.04	+0.03	—0.14	—0.62	+0.04	19 49 40.71	19 50 06.11	+26.09	+.01
θ Aquilæ	D	11	+0.04	+0.03	—0.14	—0.72	+0.09	20 05 24.49	20 05 49.81	+26.07	+.03
o¹ Seq. Cygni ...	D	8	+0.04	+0.05	—0.20	—0.11	+0.11	20 09 52.07	20 10 18.22	+26.30	—.17
α² Capricorni ...	D	11	+0.03	+0.02	—0.14	—0.87	+0.12	20 11 44.87	20 12 10.10	+26.10	.00
ι Cygni	D	11	0.03	+0.04	—0.18	—0.05	+0.12	20 17 50.69	20 18 25.79	+26.17	—.07
θ Cephei	D	11	+0.03	+0.06	—0.30	+0.79	+0.13	20 27 23.03	20 27 49.80	+26.09	+.01
α Cygni	D	11	+0.03	+0.04	—0.19	+0.07	+0.15	20 37 23.34	20 37 49.56	+26.15	+.05
η Cephei	D	11	+0.03	+0.06	—0.29	+0.71	+0.18	20 42 42.78	20 43 09.43	+25.99	+.08
32 Vulpeculæ ...	D	11	+0.03	+0.03	—0.15	—0.30	+0.20	20 49 36.65	20 50 02.54	+26.11	—.01
ν Cygni	D	11	+0.02	+0.03	—0.18	—0.04	+0.20	20 52 47.44	20 53 13.55	+26.10	.00
ν Aquarii	D	11	+0.02	+0.02	—0.14	—0.86	+0.22	21 03 23.60	21 03 46.97	+26.18	—.03
α Equulei	D	11	+0.02	+0.02	—0.14	—0.63	+0.24	21 10 05.73	21 10 31.25	+26.08	+.07
1 H Drac. L. C	Ref.	5	—0.03	+0.12	+0.96	—6.04	+0.26	21 21 25.66	9 21 46.71	+25.78	+.09
1 H. Drac. L. C	Dir.	5	+0.03	—0.12	+0.96	—6.04	+0.26	21 21 25.93	....	......	......

Chronometer correction at 19.2 hours: Chronometer time, + 26.098 s.
hourly rate, + 0.118
azimuth, — 1.039

Collimation = c.

s.
—0.110
—0.127
—0.126
Mean, —0.121

TABLE 36.—*Observation equations, Ann Arbor, Mich., August 8, 1893.*

[Epoch, 19.2 hours, chronometer time. $\Delta t = +26.00 + \delta\theta$.]

	p		p
$-4.74a -2.22\rho + \delta\theta - 4.48 = v$	0.049	$+0.593a + 0.67\rho + \delta\theta + 0.49 = v$	1
		$+0.688a + 0.93\rho + \delta\theta + 0.57 =$	1
$+0.879a - 2.09\rho + \delta\theta + 1.09 =$	1	$+0.105a + 1.01\rho + \delta\theta - 0.30 =$	0.71
$+0.117a - 1.97\rho + \delta\theta + 0.28 =$	1	$+0.842a + 1.04\rho + \delta\theta + 0.65 =$	1
$-0.287a - 1.69\rho + \delta\theta - 0.22 =$	0.65	$+0.054a + 1.14\rho + \delta\theta - 0.24 =$	1
$+0.876a - 1.64\rho + \delta\theta + 1.05 =$	1	$-0.756a + 1.30\rho + \delta\theta - 1.01 =$	0.46
$-0.095a - 1.57\rho + \delta\theta - 0.11 =$	0.75		
$+0.283a - 1.46\rho + \delta\theta + 0.31 =$	1	$-0.064a + 1.47\rho + \delta\theta - 0.37 =$	1
		$-0.686a + 1.56\rho + \delta\theta - 0.88 =$	0.48
$-1.257a - 1.27\rho + \delta\theta - 0.18 =$	0.67	$+0.286a + 1.67\rho + \delta\theta - 0.01 =$	1
$+0.548a - 1.12\rho + \delta\theta - 0.61 =$	1	$+0.035a + 1.73\rho + \delta\theta - 0.26 =$	1
$+0.958a - 1.04\rho + \delta\theta + 0.96 =$	1	$+0.827a + 1.90\rho + \delta\theta + 0.51 =$	1
$+0.711a - 0.90\rho + \delta\theta + 0.80 =$	1	$+0.610a + 2.01\rho + \delta\theta + 0.36 =$	1
$-1.709a - 0.77\rho + \delta\theta - 1.64 =$	0.23		
$+0.080a - 0.61\rho + \delta\theta + 0.05 =$	1	$-5.81a + 2.20\rho + \delta\theta + 6.05 =$	0.052
$+15.87a - 0.33\rho + \delta\theta + 15.59 =$	0.006		

Normal equations.

$$[+11.65]a + 0.24\rho + 7.08\,\delta\theta + 11.38 = 0$$
$$+0.24a[+43.91]\rho + 0.48\,\delta\theta - 4.98 = 0$$
$$+7.08a + 0.48\rho\,[+21.05]\delta\theta + 5.23 = 0$$

Results.

	s.
$\delta\theta =$	$+0.098$
$\rho =$	$+0.118$
$a =$	-1.039

TABLE 37.—*Time determination, Ann Arbor, Mich., August 9, 1893.*

[First Lieut. Charles S. Riché, observer.]

Star.	Vision.	Number of wires.	b.	Bb.	C. (c. + abn.).	Aa.	Rp.	Chronometer time of transit = t	Right ascension = α.	Chron correction. Δt.	$\sqrt{p}$ v (co.—ob.).
			s.	s.	s.	s.	s.	h. m. s.	h. m. s.	s.	s.
ε Urs Min	Ref.	4	−0.09	−0.49	−0.83	+5.17	−0.20	16 56 27.55	16 56 59.19	+27.99	+.07
ε Urs Min	Dir	3	0.09	0.49	0.83	+5.17	0.20	16 56 26.56	....	......	......
ξ Ophiuchi	D	11	+0.02	+0.01	−0.12	−0.96	−0.19	17 03 49.80	17 04 16.81	+28.27	+.03
π Herculis	D	11	0.02	+0.02	0.14	−0.13	−0.18	17 10 53.84	17 11 21.22	+28.31	−.01
β Draconis	D	11	0.01	+0.02	−0.18	0.31	−0.15	17 27 34.61	17 28 02.97	+28.36	−.05
ε Serpentis	D	11	0.01	+0.01	−0.12	−0.90	−0.15	17 31 03.01	17 31 30.07	+28.28	+.02
ι Herculis	D	11	+0.01	0.01	0.16	0.10	0.14	17 36 00.60	17 36 28.79	+28.38	−.07
μ Herculis	D	9	0.01	0.01	−0.13	−0.31	−0.13	17 41 50.57	17 42 18.41	+28.40	−.10
γ Draconis	D	11	0.00	0.01	0.18	+0.28	−0.11	17 53 41.14	17 54 09.42	+28.28	+.02
72 Ophiuchi	D	11	0.00	0.00	−0.11	−0.60	−0.10	18 01 51.48	18 02 18.94	+28.27	.03
μ Sagittarii	D	11	0.00	0.00	0.12	1.05	0.09	18 06 57.67	18 07 24.67	+28.26	+.04
η Serpentis	D	11	0.00	0.00	0.11	0.78	−0.08	18 15 21.58	18 15 48.86	+28.25	+.05
χ Draconis	D	11	0.00	−0.01	−0.38	+1.85	−0.07	18 22 32.23	18 23 01.76	+28.14	.08
α Lyræ	D	11	0.00	0.00	0.14	−0.09	−0.05	18 32 53.18	18 33 21.22	+28.32	−.02
51 H. Ceph. L. C	Ref	4	−0.02	0.32	2.31	−17.32	−0.03	18 49 58.01	6 50 11.92	+28.63	−.03
51 H. Ceph. L. C	Dir	3	0.02	0.32	+2.31	−17.32	0.03	18 49 58.65	....	......	......
β Aquilæ	D	11	0.01	0.00	−0.11	−0.65	+0.06	19 49 38.54	19 50 06.11	+28.27	+.03
θ Aquilæ	D	11	0.01	0.00	0.11	−0.75	+0.06	20 05 22.38	20 05 49.81	+28.21	+.09
o¹ Seq. Cygni	D	8	0.01	0.01	−0.16	0.11	+0.09	20 09 49.84	20 10 18.22	+28.55	−.21
α² Capricorni	D	11	0.01	0.00	−0.12	−0.92	+0.09	20 11 42.73	20 12 10.10	+28.32	−.02
γ Cygni	D	11	0.01	0.02	−0.15	−0.06	+0.10	20 17 57.52	20 18 25.79	+28.36	−.06
θ Cephei	D	11	0.02	0.03	−0.24	+0.83	+0.10	20 27 20.80	20 27 49.79	+28.27	+.02
α Cygni	D	11	0.02	0.03	−0.16	+0.07	+0.13	20 37 21.16	20 37 49.56	+28.33	−.03
η Cephei	D	11	+0.02	0.04	0.24	+0.75	+0.14	20 42 40.48	20 43 09.42	+28.25	+.03
32 Vulpeculæ	D	11	0.02	0.02	−0.13	−0.31	+0.15	20 49 34.49	20 50 02.55	+28.33	−.03
ν Cygni	D	11	0.02	0.03	−0.15	−0.04	+0.16	20 52 45.27	20 53 13.55	+28.28	+.02
ε Aquarii	D	11	0.03	0.02	0.12	0.90	+0.17	21 03 21.58	21 03 48.98	+28.23	+.07
α Equulei	D	11	0.03	0.02	0.11	−0.67	+0.18	21 10 03.57	21 10 31.26	+28.27	.03
1 H. Drac. L. C	Ref	5	0.08	+0.33	+0.79	−6.34	+0.20	21 21 23.31	9 21 46.73	+28.44	−.03
1 H. Drac. L. C	Dir	6	0.08	0.33	+0.79	−6.34	+0.20	21 21 23.07	....	......	......

Chronometer correction at 19.2 hours Chronometer time, +28s.300; hourly rate, +0.000; azimuth, —1.091

Collimation = c.

s.
−0.092
−0.096
−0.101
Mean—0.096

TABLE 38.—*Observation equations, Ann Arbor, Mich., August 9, 1893.*

[Epoch, 19.2 hours, chronometer time. $\Delta t = +28.00 + \delta\theta$.]

$$
\begin{array}{rl}
 & p \\
-4.74a - 2.22\rho + \delta\theta - 4.96 = v & 0.049 \\
 & \\
+0.879a - 2.09\rho + \delta\theta + 0.88 = & 1 \\
+0.117a - 1.97\rho + \delta\theta \quad 0.00 = & 1 \\
-0.287a - 1.69\rho + \delta\theta - 0.52 = & 0.65 \\
+0.876a - 1.64\rho + \delta\theta + 0.83 = & 1 \\
-0.095a - 1.57\rho + \delta\theta - 0.34 = & 0.75 \\
+0.283a - 1.46\rho + \delta\theta + 0.04 = & 0.97 \\
 & \\
-0.257a - 1.27\rho + \delta\theta - 0.45 = & 0.67 \\
+0.548a - 1.12\rho + \delta\theta + 0.43 = & 1 \\
+0.958a - 1.04\rho + \delta\theta + 0.88 = & 1 \\
+0.711a - 0.90\rho + \delta\theta + 0.61 = & 1 \\
-1.700a - 0.77\rho + \delta\theta - 1.92 = & 0.23 \\
+0.080a - 0.61\rho + \delta\theta - 0.18 = & 1 \\
 & \\
+15.87a - 0.33\rho + \delta\theta + 16.72 = & 0.006
\end{array}
$$

$$
\begin{array}{rl}
 & p \\
+0.593a + 0.67\rho + \delta\theta + 0.32 = v & 1 \\
+0.688a + 0.93\rho + \delta\theta + 0.46 = & 1 \\
+0.105a + 1.01\rho + \delta\theta - 0.53 = & 0.71 \\
+0.842a + 1.04\rho + \delta\theta + 0.51 = & 1 \\
+0.054a + 1.14\rho + \delta\theta - 0.40 = & 1 \\
-0.756a + 1.30\rho + \delta\theta - 1.20 = & 0.45 \\
 & \\
-0.064a + 1.47\rho + \delta\theta - 0.53 = & 1 \\
-0.686a + 1.56\rho + \delta\theta - 1.14 = & 0.48 \\
+0.286a + 1.67\rho + \delta\theta - 0.17 = & 1 \\
+0.035a + 1.73\rho + \delta\theta - 0.40 = & 1 \\
+0.827a + 1.90\rho + \delta\theta + 0.50 = & 1 \\
+0.610a + 2.01\rho + \delta\theta + 0.22 = & 1 \\
 & \\
+5.81a + 2.20\rho + \delta\theta + 5.70 = & 0.064
\end{array}
$$

Normal equations.

$$
\begin{array}{l}
[+11.72]a + 0.27\,\rho + 7.06\,\delta\theta + 10.64 = 0 \\
+0.27a\ [+43.86]\rho + 0.53\,\delta\theta - 3.80 = 0 \\
+7.06a + 0.53\,\rho\,[+21.02]\delta\theta + 1.35 = 0
\end{array}
$$

Results.

$$
\begin{array}{rl}
 & s. \\
\delta\theta = & +0.300 \\
\rho = & +0.090 \\
a = & -1.091
\end{array}
$$

TABLE 39.—*Time determination, Ann Arbor, Mich., August 12, 1893.*

[First Lieut. Charles S. Riché, observer.]

Star.	Vision.	Number of wires.	b.	Bb.	C. (c. + abn.).	Aa.	$R\rho$.	Chronometer time of transit $=t$.	Right ascension $=a$.	Chron. correction. Δt.	$\sqrt{p}\,v$ (co.—ob.).
			s.	*s.*	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*
η Ophiuchi	D	10	+0.02	+0.01	-0.14	-0.79	-0.21	17 03 43.19	17 04 16.78	+34.72	+.05
π Herculis	D	11	+0.02	+0.02	-0.17	-0.10	-0.20	17 10 46.77	17 11 21.16	+34.84	-.07
β Draconis	D	11	+0.02	+0.03	-0.23	+0.26	-0.17	17 27 28.04	17 28 02.89	+34.96	-.15
ξ Serpentis	D	8	+0.02	+0.01	-0.14	-0.79	-0.17	17 30 56.61	17 31 30.04	+34.52	+.24
ι Herculis	D	10	+0.02	+0.03	-0.20	+0.09	-0.16	17 35 54.05	17 36 28.72	+34.91	-.12
μ Herculis	D	11	+0.02	+0.02	-0.16	-0.25	-0.15	17 41 44.03	17 42 18.37	+34.88	-.11
γ Draconis	D	11	+0.02	+0.03	-0.22	+0.23	-0.13	17 53 34.51	17 54 09.35	+34.93	-.13
72 Ophiuchi	D	11	+0.02	+0.02	-0.14	-0.49	-0.11	18 01 44.84	18 02 18.91	+34.79	-.02
μ Sagittarii	D	11	+0.02	+0.02	-0.15	-0.86	-0.11	18 06 51.04	18 07 24.65	+34.71	+.06
η Serpentis	D	11	+0.02	+0.02	-0.14	-0.64	-0.09	18 15 14.94	18 15 48.84	+34.75	+.02
χ Draconis	D	11	+0.02	+0.06	-0.47	+1.52	-0.08	18 22 25.61	18 23 01.59	+34.95	-.09
α Lyræ	D	11	+0.02	+0.03	-0.18	-0.07	-0.06	18 32 46.63	18 33 21.18	+34.83	-.06
51 H. Cehp. L. C.	Ref.	4	-0.04	+0.58	+2.86	-14.26	-0.03	18 49 49.48	6 50 13.05	+34.42	+.03
51 H. Ceph. L. C.	Dir.	4	+0.04	-0.58	+2.86	-14.26	-0.03	18 49 50.64	....	....	......
β Aquilæ	D	11	+0.02	+0.01	-0.14	-0.53	+0.07	19 49 31.91	19 50 06.11	+34.79	-.02
θ Aquilæ	D	11	+0.02	+0.01	-0.14	-0.62	+0.09	20 05 15.78	20 05 49.82	+34.70	+.07
o¹ Seq. Cygni	D	8	+0.02	+0.02	-0.20	-0.09	+0.10	20 09 43.34	20 10 18.20	+35.03	-.22
α² Capricorni	D	11	+0.01	+0.01	-0.14	-0.76	+0.11	20 11 36.12	20 12 10.11	+34.77	.00
γ Cygni	D	11	+0.01	+0.02	-0.18	-0.05	+0.12	20 17 51.04	20 18 25.78	+34.83	-.06
θ Cephei	D	11	+0.01	+0.03	-0.30	+0.68	+0.13	20 27 14.40	20 27 49.76	+34.82	-.03
α Cygni	D	11	+0.01	+0.02	-0.20	+0.06	+0.15	20 37 14.70	20 37 49.55	+34.82	-.05
η Cephei	D	11	+0.01	+0.02	-0.29	+0.62	+0.16	20 42 34.13	20 43 09.40	+34.76	+.01
32 Vulpeculæ	D	11	+0.01	+0.01	-0.16	-0.26	+0.17	20 49 27.99	20 50 02.55	+34.80	-.03
ν Cygni	D	11	+0.01	+0.01	-0.18	-0.03	+0.18	20 52 38.75	20 53 13.56	+34.83	-.06
ν Aquarii	D	11	+0.01	+0.01	-0.14	-0.74	+0.19	21 03 14.91	21 03 49.00	+34.77	.00
α Equulei	D	11	+0.01	+0.01	-0.14	-0.55	+0.21	21 09 57.06	21 10 31.28	+34.69	+.08
1 H. Drac. L. C.	Ref.	5	+0.01	-0.04	+0.97	-5.21	+0.22	21 21 16.64	9 21 46.88	+34.30	+.11
1 H. Drac. L. C.	Dir.	6	-0.01	+0.04	+0.97	-5.21	+0.22	21 21 16.56	....	....	......

Chronometer correction at 19.2 hours: Chronometer time, +34.768; hourly rate, +0.102; azimuth -0.897.

Collimation=c.

s.
-0.122
-0.099
-0.149
Mean -0.123

TABLE 40.—*Observation equations, Ann Arbor, Mich., August 12, 1893.*

[Epoch, 19.2 hours, chronometer time. $\Delta t = +\overset{s.}{34.00} + \delta\theta$.]

	p		p
$+0.879a - 2.09\rho + \delta\theta + 0.28 = v$	0.99	$+0.593a + 0.67\rho + \delta\theta - 0.33 = v$	1
$+0.117a - 1.97\rho + \delta\theta - 0.54 =$	1	$+0.688a + 0.93\rho + \delta\theta - 0.17 =$	1
$-0.287a - 1.69\rho + \delta\theta - 1.05 =$	0.65	$+0.105a + 1.01\rho + \delta\theta - 1.04 =$	0.71
$+0.876a - 1.64\rho + \delta\theta + 0.44 =$	0.96	$+0.842a + 1.04\rho + \delta\theta - 0.12 =$	1
$-0.095a - 1.57\rho + \delta\theta - 0.84 =$	0.74	$+0.054a + 1.14\rho + \delta\theta - 0.90 =$	1
$+0.283a - 1.46\rho + \delta\theta - 0.48 =$	1	$-0.756a + 1.30\rho + \delta\theta - 1.63 =$	0.45
$-0.257a - 1.27\rho + \delta\theta - 1.03 =$	0.67	$-0.064a + 1.47\rho + \delta\theta - 1.03 =$	1
$+0.548a - 1.12\rho + \delta\theta - 0.19 =$	1	$-0.686a + 1.56\rho + \delta\theta - 1.54 =$	0.48
$+0.958a - 1.04\rho + \delta\theta + 0.26 =$	1	$+0.286a + 1.67\rho + \delta\theta - 0.71 =$	1
$+0.711a - 0.90\rho + \delta\theta - 0.02 =$	1	$+0.035a + 1.73\rho + \delta\theta - 0.98 =$	1
$-1.700a - 0.77\rho + \delta\theta - 2.39 =$	0.23	$+0.827a + 1.90\rho + \delta\theta - 0.22 =$	1
$+0.080a - 0.61\rho + \delta\theta - 0.70 =$	1	$+0.610a + 2.01\rho + \delta\theta - 0.35 =$	1
$+15.87a - 0.33\rho + \delta\theta + 13.87 =$	0.006	$+5.81a + 2.20\rho + \delta\theta + 4.69 =$	0.054

Normal equations.

$$[+10.58]a - 0.17\,\rho + 7.28\,\delta\theta + 3.94 = 0$$
$$-0.17\,a\ [+43.50]\rho + 0.71\,\delta\theta - 5.16 = 0$$
$$+7.28\,a + 0.71\,\rho\ [+20.94]\delta\theta - 9.61 = 0$$

Results.

$$\delta\theta = +\overset{s.}{0.768}$$
$$\rho = +0.102$$
$$a = -0.897$$

TABLE 41.—*Collimation Würdemann transit No. 1. Sault Ste. Marie, Mich.*

[Clamp E, mean of wires.]

Date.	β Urs. Min.	ε Urs. Min.	δ Urs. Min.	χ Cephei.	51 H. Ceph, L. C.	λ Urs. Min.	1 H. Drac L. C.	Means.	Observer.
1893.	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	
July 10..	0.426	0.339	0.352	-0.273	....	....	....	+0.348	First Lieut. Charles S. Riché.
15..	0.120	0.525	0.343	0.131	....	....	....	-0.230	
19..	....	0.434	....	....	-0.318	-0.345	-0.278	+0.344	
20..	....	0.203	....	....	+0.272	-0.306	-0.364	+0.286	
26..	....	0.292	....	....	0.430	-0.166	-0.357	0.311	
Aug. 6..	....	0.312	....	....	0.182	0.304	0.293	0.273	Prof. Asaph Hall, jr.
7..	....	0.319	....	....	0.461	-0.294	-0.243	-0.329	
8..	....	0.163	....	....	0.163	-0 263	0.356	-0.236	
9..	....	0.237	....	....	0.384	*[-0.690]	-0.271	-0.297	
12..	....	0.191	....	....	-0.216	0.286	-0.335	+0.257	

* Rejected.

Collimation Pistor and Martin's meridian circle, Ann Harbor, Mich.

[Telescope direct, mean of wires.]

Date.	By collimators. First result.	Second result.	Third result.	Means.	Observer.
	s.	*s.*	*s.*	*s.*	
July 10..	-0.231	-0.230	....	-0.230	Prof. Asaph Hall, jr.
15..	-0.172	-0.122	....	-6.147	
19..	-0.216	-0.131	....	-0.174	
20..	-0.178	-0.197	....	-0.188	
26..	-0.194	-0.178	....	-0.186	
Aug. 6..	-0.123	-0.200	-0.126	-0.150	First Lieut. Charles S. Riché.
7..	-0.158	-0.149	-0.111	-0.139	
8..	-0.110	-0.127	-0.126	-0.121	
9..	-0.092	-0.096	-0.101	-0.096	
12..	-0.122	-0.099	-0.149	-0.123	

TABLE 42.—*Results of observations for time.*

SAULT STE. MARIE, MICH.

Date.	Epoch clock time.	Clock correction.	Hourly rate.	Azimuth.		Observer.
1893.	*hrs.*	*s.*	*s.*	*s.*	*s.*	
July 10..	17.5	12.194	0.134	−1.876	−2.663	First Lieut. Charles S. Riché.
15..	17.5	11.232	0.022	−2.139		
19..	19.2	10.019	0.039	−1.083	−1.497	
20..	19.2	10.003	−0.024	−2.034		
26..	19.2	8.600	−0.013	0.183 (1st)	−0.077 (2d)	
				−0.647 (3d)	−0.958 (4th)	
Aug. 6..	19.2	7.241	−0.000	−0.746	−1.062	Prof. Asaph Hall, jr.
7..	19.2	7.548	−0.008	−0.701		
8..	19.2	7.905	−0.025	−0.823		
9..	19.2	8.184	0.026	−0.596		
12	19.2	9.004	0.020	−0.288 (1st)	−0.579 (2d)	
				−0.896 (3d)		

ANN ARBOR, MICH.

Date.	Epoch chronometer time.	Chronometer correction	Hourly rate.	Azimuth.	Observer.
1893.	*hrs.*	*s.*	*s.*	*s.*	
July 10..	17.5	−52.619	0.094	0.113	Prof. Asaph Hall, jr.
15..	17.5	−36.858	0.127	0.032	
19..	19.2	−24.201	0.135	0.043	
20..	19.2	−21.165	0.080	0.023	
26	19.2	−4.643	0.133	−0.822	
Aug. 6..	19.2	22.693	0.036	−1.017	First Lieut. Charles S. Riché.
7..	19.2	23.983	0.069	−0.981	
8..	19.2	26.0[illegible]8	0.118	−1.039	
9..	19.2	28.300	0.090	−1.091	
12..	19.2	34.768	0.102	−0.897	

TABLE 43.—*Difference of longitude, Sault Ste. Marie and Ann Arbor, Mich.*

[Results of clock and chronometer comparisons.]

Date.	Signals from—	Number of signals.	Ann Arbor, Prof. Asaph Hall, jr., observer. Means of chronometer times of comparisons.	Ann Arbor: Chronometer corrections.	Ann Arbor: Means of sidereal times of comparisons.	Sault Ste. Marie, First Lieut. Charles S. Riché, observer. Means of clock times of comparisons.	Sault Ste. Marie: Clock corrections.	Sault Ste. Marie: Means of sidereal times of comparisons.	Differences of time. Signals from Sault Ste. Marie.	Differences of time. Signals from Ann Arbor.
			h. m. s.	s.	h. m. s.	h. m. s.	s.	h. m. s.	m. s.	m. s.
July 10	Sault Ste. Marie	15	17 19 13.738	—52.638	17 18 21.100	17 15 41.000	+12.161	17 15 53.161	2 27.939	....
		15	17 23 40.729	—52.631	17 22 48.098	17 20 08.000	+12.170	17 20 20.170	2 27.928	....
		15	17 24 05.728	—52.631	17 23 13.097	17 20 33.000	+12.171	17 20 45.171	2 27.926	....
		15	17 28 52.321	—52.623	17 27 59.698	17 25 19.642	+12.182	17 25 31.824	2 27.874	....
		15	17 30 04.328	—52.622	17 29 11.706	17 26 31.652	+12.185	17 26 43.837	2 27.869	....
		15	17 33 48.403	—52.616	17 32 55.787	17 30 15.730	+12.194	17 30 27.924	2 27.863	....
	Ann Arbor	15	17 21 52.000	—52.635	17 20 59.365	17 18 19.365	+12.167	17 18 31.532	....	2 27.833
		15	17 26 27.000	—52.627	17 25 34.373	17 22 54.386	+12.177	17 23 06.563	....	2 27.810
		15	17 26 42.000	—52.627	17 25 39.373	17 23 09.391	+12.177	17 23 21.568	....	2 27.805
		15	17 31 35.275	—52.610	17 30 42.656	17 28 02.087	+12.189	17 28 14.876	....	2 27.780
		15	17 32 13.230	—52.618	17 31 20.612	17 28 40.640	+12.190	17 28 52.830	....	2 27.782
		15	17 35 46.284	—52.612	17 34 53.672	17 32 13.703	+12.198	17 32 25.901	....	2 27.771
								Mean both ways.	+2 27.848	
July 15	Sault Ste. Marie	15	17 08 16.10	—36.903	17 07 39.197	17 05 00.000	+11.223	17 05 11.223	2 27.974	....
		15	17 09 16.10	—36.901	17 08 39.190	17 06 00.000	+11.223	17 06 11.223	2 27.976	....
		1	17 25 00.00	—36.968	17 24 23.222	17 21 44.000	+11.229	17 21 55.229	2 27.993	....
		15	17 14 02.454	—36.893	17 13 25.561	17 10 46.378	+11.225	17 10 57.603	2 27.958	....
		15	17 14 42.413	—36.890	17 14 05.523	17 11 26.346	+11.225	17 11 37.571	2 27.952	....
		15	17 19 22.420	—36.876	17 18 45.544	17 16 06.392	+11.227	17 16 17.619	2 27.925	....
	Ann Arbor	....	17 00 00.00	—36.902	17 08 23.098	17 05 44.00	+11.223	17 05 55.223	....	2 27.875
		....	17 20 00.00	—36.860	17 28 23.140	17 25 44.00	+11.230	17 25 55.230	....	2 27.910
		15	17 16 40.264	—36.886	17 16 12.878	17 13 33.287	+11.230	17 13 44.518	....	2 27.865
		15	17 17 10.247	—36.884	17 16 42.363	17 14 03.279	+11.226	17 14 14.506	....	2 27.858
		15	17 22 24.253	—36.874	17 21 47.379	17 19 08.223	+11.228	17 19 19.450	....	2 27.869
								Mean both ways.	+2 27.925	
July 19	Sault Ste. Marie	15	19 04 29.321	—34.210	19 03 05.106	19 00 27.000	+10.012	19 00 37.012	2 28.093	....
		16	19 05 10.314	—34.212	19 04 46.102	19 02 08.000	+10.013	19 02 18.013	2 28.089	....
		15	19 09 48.207	—34.202	19 09 24.105	19 06 46.000	+10.016	19 06 56.016	2 28.089	....

		9	19 15 20.690	−24.192	19 14 56.498	19 12 18.418	+10.020	19 12 28.438	2 28.060	....
		9	19 15 42.692	−24.189	19 15 18.503	19 12 40.418	+10.020	19 12 50.438	2 28.065	....
		9	19 16 16.688	−24.187	19 15 52.501	19 13 14.428	+10.021	19 13 24.449	2 28.052	....
	Ann Arbor	15	19 07 10.000	−24.208	19 06 45.792	19 04 07.787	+10.015	19 04 17.802	....	2 27.990
		15	19 07 43.000	−24.206	19 07 18.794	19 04 40.787	+10.015	19 04 50.802	....	2 27.992
		15	19 11 52.000	−24.198	19 11 27.802	19 08 49.785	+10.017	19 08 59.802	....	2 28.000
		5	19 20 25.840	−24.178	19 20 01.662	19 17 23.640	+10.023	19 17 33.663	....	2 27.909
		5	19 20 41.550	−24.177	19 20 17.373	19 17 39.384	+10.023	19 17 49.407	....	2 27.966
		3	19 21 03.640	−24 177	19 20 39.463	19 18 01.478	+10.024	19 18 11.502	....	2 27.961
								Mean both ways.	+2 28.028	
July 20	Sault Ste. Marie	......	18 59 00.100	−21.181	18 58 38.919	18 56 01.000	+10.009	18 56 11.009	2 27.910	....
		15	19 07 38.557	−21.168	19 07 17.389	19 04 39.481	+10.005	19 04 49.486	2 27.903	....
		15	19 08 08.542	−21.167	19 07 47.375	19 05 09.448	+10.005	19 05 19.453	2 27.922	....
		15	19 12 51.481	−21.162	19 12 30.319	19 09 52.415	+10.003	19 10 02.418	2 27.901	....
	Ann Arbor	......	19 03 00.000	−21.175	19 02 38.825	19 00 01.000	+10.007	19 00 11.007	....	2 27.818
		15	19 09 32.297	−21.173	19 09 11.124	19 06 33.316	+10.005	19 06 43.321	....	2 27.803
		15	19 10 25.233	−21.165	19 10 04.068	19 07 26.261	+10.004	19 07 36.265	....	2 27.803
		15	19 14 47.218	−21.159	19 14 26.059	19 11 48.246	+10.003	19 11 58.249	....	2 27.810
								Mean both ways.	+2 27.861	
July 26	Sault Ste. Marie (*)	......	....	....	....	....	....	....	....	....
		15	19 18 41.410	− 4.624	19 18 36.786	19 16 00.431	+8.599	19 16 09.030	2 27.756	....
		15	19 19 51.329	− 4.622	19 19 46.707	19 17 10.367	+8.599	19 17 18.966	2 27.741	....
		15	19 23 11.351	− 4.614	19 23 06.737	19 20 30.361	+8.598	19 20 38.959	2 27.778	....
	Ann Arbor (†)	......	....	....	....	....	....	....	....	....
		15	19 20 46.271	− 4.619	29 20 41.652	19 18 05.350	+8.598	19 18 13.948	....	2 27.704
		15	19 21 17.249	− 4.618	19 21 12.631	19 18 36.333	+8.598	19 18 44.931	....	2 27.700
		15	19 25 42.277	− 4.608	19 25 37.669	19 23 01.351	+8.597	19 23 09.948	....	2 27.721
								Mean both ways.	+2 27.733	

* Clock signals coincide too closely to be read.

† Chronometer signals coincide too closely to be read.

TABLE 43.—*Difference of longitude, Sault Ste. Marie and Ann Arbor, Mich.*—Continued.

[Results of clock and chronometer comparisons.]

Date.	Signals from	Number of signals.	Ann Arbor, First Lieut. Charles S. Riché, observer. Means of chronometer times of comparisons.	Chronometer corrections.	Means of sidereal times of comparisons.	Sault Ste. Marie, Prof. Asaph Hall, jr., observer. Means of clock times of comparisons.	Clock corrections.	Means of sidereal times of comparisons.	Differences of time. Signals from Sault Ste. Marie.	Signals from Ann Arbor.
			h. m. s.	s.	h. m. s.	h. m. s.	s.	h. m. s.	m. s.	m. s.
Aug. 6	Sault Ste. Marie	15	19 04 30.299	+22.090	19 04 52.389	19 02 17.000	+7.241	19 02 24.241	2 28.148	....
		15	19 08 45.297	+22.092	19 09 07.389	19 06 32.000	+7.241	19 06 39.241	2 28.148	....
		15	19 10 05.293	+22.093	19 10 27.386	19 07 52.000	+7.241	19 07 59.241	2 28.145	....
		15	19 12 56.767	+22.095	19 13 18.862	19 10 43.471	+7.241	19 10 50.712	2 28.150	....
		15	19 14 06.725	+22.095	19 14 28.820	19 11 53.436	+7.241	19 12 00.677	2 28.143	....
		27	19 34 08.694	+22.107	19 34 30.801	19 31 55.414	+7.241	19 32 02.655	2 28.146	....
	Ann Arbor	15	19 07 52.000	+22.092	19 08 14.092	19 05 38.799	+7.241	19 05 46.040	....	2 28.052
		15	19 11 08.000	+22.093	19 11 30.093	19 08 54.801	+7.241	19 09 02.042	....	2 28.051
		15	19 11 23.000	+22.094	19 11 45.094	19 09 09.796	+7.241	19 09 17.037	....	2 28.057
		11	19 15 26.704	+22.096	19 15 48.800	19 13 13.485	+7.241	19 13 20.726	....	2 28.074
		11	19 31 55.177	+22.106	19 32 17.283	19 29 41.973	+7.241	19 29 49.214	....	2 28.060
		13	19 32 20.528	+22.106	19 32 42.634	19 30 07.331	+7.241	19 30 14.572	....	2 28.062
								Mean both ways.	+2 28.103	
Aug. 7	Sault Ste. Marie	15	18 59 19.699	+23.971	18 59 43.670	18 57 08.000	+7.550	18 57 15.550	2 28.120	....
		15	19 04 43.700	+23.977	19 04 07.677	19 02 32.000	+7.549	19 02 39.549	2 28.128	....
		15	19 04 58.698	+23.977	19 05 22.675	19 02 47.000	+7.549	19 02 54.549	2 28.126	....
		15	19 08 34.209	+23.981	19 08 58.190	19 06 22.536	+7.549	19 06 30.085	2 28.105	....
		15	19 09 24.239	+23.982	19 09 48.221	19 07 12.565	+7.548	19 07 20.113	2 28.108	....
		15	19 13 36.139	+23.987	19 14 00.126	19 11 24.464	+7.548	19 11 32.012	2 28.114	....
	Ann Arbor	15	19 01 20.000	+23.973	19 01 43.973	18 59 08.395	+7.550	18 59 15.945	....	2 28.028
		15	19 01 43.000	+23.973	19 02 06.973	19 00 31.403	+7.549	19 00 38.952	....	2 28.021
		15	19 06 15.000	+23.979	19 06 38.979	19 04 03.412	+7.549	19 04 10.961	....	2 28.018
		11	19 10 30.714	+23.983	19 10 54.697	19 08 19.105	+7.548	19 08 23.653	....	2 28.044
		9	19 11 50.770	+23.985	19 12 14.755	19 09 39.168	+7.548	19 09 46.716	....	2 28.039
		15	19 15 42.448	+23.989	19 16 06.437	19 13 30.859	+7.548	19 13 38.407	....	2 28.030
								Mean both ways.	+2 28.074	

Aug. 8	Sault Ste. Marie (*)		18 58 10.00			18 56 00.00				
		19	19 03 06.397	+26.084	19 03 32.481	19 00 56.445	+7.909	19 01 04.354	2 28.127	
		27	19 04 00.405	+26.086	19 04 26.491	19 01 50.446	+7.909	19 01 58.355	2 28.136	
		27	19 08 27.422	+26.094	19 08 53.516	19 06 17.476	+7.907	19 06 25.383	2 28.133	
	Ann Arbor	49	19 00 35.000	+26.079	19 01 01.079	18 58 25.100	+7.910	18 58 33.010		2 28.069
		49	19 01 35.000	+26.081	19 02 01.081	18 59 25.100	+7.910	18 59 33.010		2 28.071
		21	19 05 17.503	+26.089	19 05 43.592	19 03 07.619	+7.908	19 03 15.527		2 28.065
		21	19 06 01.552	+26.090	19 06 27.642	19 03 51.688	+7.908	19 03 59.596		2 28.046
		21	19 10 33.502	+26.099	19 10 59.601	19 08 23.638	+7.906	19 08 31.544		2 28.057
								Mean both ways.	+2 28.098	
Aug. 9	Sault Ste. Marie	15	18 58 30.135	+28.283	18 58 58.418	18 56 22.000	+8.178	18 56 30.178	2 28.240	
		15	19 00 00.129	+28.285	19 00 28.414	18 57 52.000	+8.178	18 58 00.178	2 28.236	
		15	19 03 20.568	+28.290	19 03 48.858	19 01 12.427	+8.180	19 01 20.607	2 28.251	
		15	19 04 30.554	+28.292	19 04 58.846	19 02 22.441	+8.180	19 02 30.621	2 28.225	
		15	19 07 40.581	+28.296	19 08 08.877	19 05 32.473	+8.182	19 05 40.655	2 28.222	
	Ann Arbor		19 01 00.000	+28.287	19 01 28.287	18 58 52.000	+8.179	18 59 00.179		2 28.108
			19 02 00.000	+28.287	19 02 28.287	18 59 52.000	+8.179	19 00 00.179		2 28.108
		25	19 05 42.996	+28.293	19 06 11.289	19 03 34.974	+8.181	19 03 43.155		2 28.134
		25	19 06 35.611	+28.295	19 07 03.906	19 04 27.590	+8.181	19 04 35.771		2 28.135
		29	19 10 19.504	+28.300	19 10 47.804	19 08 11.491	+8.183	19 08 19.674		2 28.130
								Mean both ways.	+2 28.180	
Aug. 12	Sault Ste. Marie	59	18 58 32.395	+34.749	18 59 07.144	18 56 30.000	+8.999	18 56 38.999	2 28.145	
		59	18 59 32.395	+34.751	19 00 07.146	18 57 30.000	+9.000	18 57 39.000	2 28.146	
		59	19 05 32.392	+34.760	19 06 07.152	19 03 30.000	+9.002	19 03 39.002	2 28.150	
		23	19 10 38.690	+34.769	19 11 13.459	19 08 36.342	+9.003	19 08 45.345	2 28.114	
		11	19 16 35.726	+34.779	19 17 10.505	19 14 33.378	+9.005	19 14 42.383	2 28.122	
		17	19 17 47.690	+34.781	19 18 22.471	19 15 45.319	+9.006	19 15 54.325	2 28.146	
	Ann Arbor	39	19 02 39.000	+34.755	19 03 13.755	19 00 36.698	+9.001	19 00 45.699		2 28.056
		59	19 03 30.000	+34.757	19 04 04.757	19 01 27.697	+9.001	19 01 36.698		2 28.059
		59	19 07 30.000	+34.764	19 08 04.764	19 05 27.696	+9.002	19 05 36.698		2 28.066
		21	19 12 52.648	+34.772	19 13 27.420	19 10 50.343	+9.004	19 10 59.347		2 28.073
		17	19 14 43.269	+34.775	19 15 18.044	19 12 40.982	+9.005	19 12 49.987		2 28.057
		21	19 19 25.678	+34.783	19 20 00.461	19 17 23.400	+9.006	19 17 32.406		2 28.055
								Mean both ways.	+2 28.099	

*Chronometer and clock beats nearly coincident.

TABLE 41.—*Results for difference of longitude, Sault Ste. Marie and Ann Arbor, Mich.*

[First Lieut. Charles S. Riché at Sault Ste. Marie; Prof. Asaph Hall, jr., at Ann Arbor.]

Date.	Difference of time. Signals from Sault Ste. Marie.	Signals from Ann Arbor.	Mean.	Correction for personal equation.	Result for difference of longitude.	Double wave and armature time.
1893.	m. s.	m. s.	m. s.	s.	m. s.	s.
July 10..	+2 27.900	+2 27.797	+2 27.848	+0.116	+2 27.964	+0.103
15..	+2 27.963	+2 27.888	+2 27.926	+0.116	+2 28.042	+0.075
19..	+2 28.073	+2 27.984	+2 28.028	+0.116	+2 28.144	+0.089
20..	+2 27.910	+2 27.812	+2 27.861	+0.116	+2 27.977	+0.098
26..	+2 27.758	+2 27.708	+2 27.733	+0.116	+2 27.849	+0.050
		Mean	+2 27.879			

[Prof. Asaph Hall, jr., at Sault Ste. Marie; First Lieut. Charles S. Riché at Ann Arbor.]

Date.	Signals from Sault Ste. Marie.	Signals from Ann Arbor.	Mean.	Correction for personal equation.	Result for difference of longitude.	Double wave and armature time.
Aug. 6..	+2 28.146	+2 28.060	+2 28.103	−0.116	+2 27.987	+0.086
7..	+2 28.117	+2 28.030	+2 28.074	−0.116	+2 27.958	+0.087
8..	+2 28.132	2 28.063	2 28.098	−0.116	+2 27.982	+0.069
9..	+2 28.236	+2 28.121	+2 28.179	−0.116	+2 28.063	+0.115
12..	+2 28.137	+2 28.061	+2 28.099	−0.116	+2 27.983	+0.076
		Mean	+2 28.111			
Sault Ste. Marie west of Ann Arbor					+2 27.995	+0.084
Personal equation, Riché observes earlier than Hall					0.116	

Difference of longitude, Sault Ste. Marie observatory, west pier, west of "Detroit" observatory meridian circle at Ann Arbor, Mich .... m. s. s. 2 27.995 ±0.036

The mean of the first five nights, July 10, 15, 19, 20, and 26, with First Lieut. Charles S. Riché, observer at Sault Ste. Marie, and Prof. Asaph Hall, jr., observer at Ann Arbor, gives $2^{m}\ 27^{s}.879$ for the difference of time between the two places. The range in five nights is $0^{s}.295$.

The mean of the second five nights, August 6, 7, 8, 9, and 12, with Prof. Asaph Hall, jr., observer at Sault Ste. Marie, and First Lieut. Charles S. Riché, observer at Ann Arbor, gives $2^{m}\ 28^{s}.111$ for the difference of time with a range of $0^{s}.105$ in the five nights.

The mean of the ten nights' observed differences of time gives for the difference of longitude, Sault Ste. Marie west of Ann Arbor $2^{m}\ 27^{s}.995 \pm 0^{s}.036$, with a range of $0^{s}.295$ in the ten nights, and for personal equation, Lieut Riché observes earlier than Prof. Hall $0^{s}.116$.

The signals from Sault Ste. Marie give a result for difference of longitude greater by $0^{s}.084$ on the average than the difference by signals from Ann Arbor. This difference, commonly called double the difference due to wave and armature time, is twice the apparent time of progression of a signal between the two places, due to the electro-static capacity of the telegraph wire, which is nearly in proportion to its length. The telegraph line between Sault Ste. Marie and Ann Arbor was continuous without repeaters.

In addition to the personal equation as derived from the results for difference of longitude with the interchange of observers, there were also made two direct determinations of the personal equation between First Lieut. Charles S. Riché and Prof. Asaph Hall, jr., one on the night of July 31 with Würdeman transit No. 1 at Sault Ste. Marie, and the other on the night of August 14 with the meridian circle at Ann Arbor.

On July 31 the method of observation was for one observer to observe a star over the first 3 wires and the other observer over the last 4. The observers interchanged wires on half the stars observed. On August 14 one observer observed the star over 3 wires, the other observer over 5 wires, and then the first observer took the star over the last 3 wires. On half the number of stars the observers interchanged wires.

The observations of each observer on a star were reduced to the mean of the wires by means of the wire interval determined for each observer. The difference in the time of transit for the two observers gives the result for personal equation.

On July 31 the mean of 35 stars of less declination than 60° gave for personal equation—

Riché observes earlier than Hall $0^{s}.144$.

On August 14 the mean of 34 stars gave—

Riché observes earlier than Hall $0^{s}.098$.

The mean of the two nights gives for personal equation—
Riché observes earlier than Hall $0^s.121$.

This result compares well with the result $0^s.116$ for personal equation as derived from the difference of longitude with interchange of observers.

On the night of September 22 observations were made for the difference of longitude between Sault Ste. Marie and the Naval Observatory at Washington, D. C.

Signals were successfully exchanged, but the observations were so broken by clouds that the work was not reduced.

AZIMUTH.

Observations for the azimuth of the line Observatory Sault Ste. Marie to station Azimuth were made by Mr. E. E. Heskell, U. S. assistant engineer, on four nights, March 2, 8, 14, and 19, by comparing the direction of the line with the direction of the star Polaris near western elongation. A few pointings on 51 Cephei near western elongation also were made on the night of March 19. The pointings to station Azimuth were made to a lamp accurately centered over the geodetic point. The length of the line Observatory to station Azimuth is 5 miles.

In determining the azimuth the large theodolite, Troughton & Simms No. 1, with a 14-inch horizontal circle, was used, reading with three microscopes. Pointings were made to the star direct and to the image reflected from mercury. The mean of the two readings is free of any error due to the axis of the pivots not being in a horizontal plane. The striding level was read during the observations, but no use was made of the readings in the reductions. The altitude of the light at station Azimuth was about 38′ above the horizon. A correction for level was made to the readings on the mark deduced from the difference in the readings on the star direct and reflected. This was always small, never amounting to more than $0''.3$.

The method of observation was as follows: First the telescope of the theodolite was directed to the light on the distant station, bisecting it with the vertical wire, and the horizontal circle read; the telescope was then directed to the image of the star reflected from the mercury, and the time of bisection noted by the clock, and the horizontal circle read again; the telescope was then directed to the star, the time noted again, and the horizontal circle read. The observations were then repeated in the reverse order on the star, the image, and the light. In the next set the star was sighted on first, then the image reflected from mercury, and then the light; the observations were then repeated in the reverse order on the light, image, and the star. The telescope was then reversed by turning the telescope in a vertical plane around its pivot axis, the object glass passing through the nadir while the telescope was slightly lifted from the wyes to permit of the motion, and then the telescope revolved 180° in a horizontal plane and the observations repeated as described above. The observations thus made are for one position of the horizontal circle. After these observations the circle was shifted by revolving the whole instrument by means of the revolving trivet on which it was mounted. Observations were made in two positions of the circle every night.

Clock No. 256, Bond & Son, was used in noting the time of observation of the star and its reflection from mercury.

The clock correction was determined by Würdemann transit No. 1 from the observation of 4 time stars and 2 slow stars, usually before the observations for azimuth were begun. The transit was mounted on the same pier used for mounting the theodolite in observing for azimuth. The transit foot plates being firmly attached to the stone pier, it was possible to always place the instrument very nearly in the meridian without any special adjustment.

The observations for azimuth were reduced by finding the azimuth of the star at elongation and applying a correction depending on the interval between the time of elongation and the time of observation. The declinations and right ascensions used were taken from the Berlin Jahrbuch.

The formula for azimuth at elongation is,

$$\sin. A_e = \sec. \varphi \cos. \delta.$$

in which,

A_e = azimuth of star at elongation.
φ = latitude of place.
δ = declination of the star.

For correction to elongation the formula was used,

$$\text{Correction} = \pm \frac{2 \sin. \frac{1}{2} \tau}{\sin. 1''} \tan. A_e$$

in whice τ is the interval in time from elongation to the time of observation. This was used for intervals not exceeding twenty-five minutes. For deriving the correc-

tion, Table VI in Chauvenet's Astronomy, Vol. II., was used. For intervals exceeding twenty-five minutes the rigorous formula for the azimuth was used,

$$\tan. A = \frac{\sin. t}{\cos.\varphi \tan.\delta - \sin.\varphi \cos. t}$$

in which,

A = the azimuth.
t = the hour angle of the star from the meridian.
φ = the latitude.
δ = the declination of the star.

To the mean result for each night the correction for diurnal aberration $+0''.3$ was applied.

In the table following the details of the results of the observations for azimuth are given:

Azimuth at observatory, Sault Ste. Marie, Mich., E. E. Haskell, observer.

[Star, date, etc.: Polaris near western elongation. March 2, 1894, $\alpha = 1^h\ 18^m\ 56^s.97$ $\delta = 88°\ 44'\ 50''.96$; $A_e = 178°\ 10'\ 48''.75$.]

Tel.	Vision.	Time from elongation.	Reduction to elongation.	Azimuth of star.	Angle between star and △ azimuth.	Azimuth of star plus the angle.	Correction for level.	Mean—azimuth of △ azimuth.
		m. s.	"	° ' "	° ' "	° ' "	"	° ' "
D	Reflected	− 38 28.7	+92.5	178 12 21.2	−5 38.6	178 06 42.6	0.0	178 06 44.8
D	Direct	36 20.2	82.4	12 11.2	5 24.0	47.2		
D	Direct	35 09.2	77.1	12 05.9	5 26.2	39.7	−0.1	35.4
D	Reflected	33 59.7	72.1	12 00.9	5 29.7	31.2		
D	Direct	30 51.7	59.4	11 48.2	5 05.7	42.5	−0.1	37.5
D	Reflected	29 44.9	55.1	11 44.0	5 11.4	32.6		
D	Reflected	26 25.7	43.5	11 32.4	5 02.8	29.0	−0.1	33.4
D	Direct	25 18.5	39.9	11 28.6	4 51.2	37.4		
R	Reflected	18 44.0	21.9	11 10.6	4 29.9	40.7	+0.1	37.2
R	Direct	17 23.2	18.8	11 07.6	4 34.1	33.5		
R	Direct	16 21.7	16.7	11 05.4	4 32.6	32.8	+0.1	39.1
R	Reflected	15 17.5	14.6	11 03.3	4 18.2	45.1		
R	Direct	13 01.0	10.6	10 59.3	4 36.0	23.3	+0.1	31.7
R	Reflected	11 56.2	8.9	10 57.6	4 17.6	40.0		
R	Reflected	8 44.7	4.8	10 53.5	4 15.0	38.5	+0.1	32.1
R	Direct	− 7 32.5	3.6	10 52.3	4 26.0	25.4		
R	Reflected	+ 2 09.3	0.3	10 49.0	3 57.7	51.3	+0.2	38.3
R	Direct	3 46.3	0.9	10 49.6	4 24.7	24.9		
R	Direct	4 42.8	1.4	10 50.1	4 35.8	14.3	+0.2	26.3
R	Reflected	5 50.3	2.2	10 50.9	4 13.0	37.9		
R	Direct	8 07.0	4.1	10 52.9	4 30.2	22.6	+0.2	34.2
R	Reflected	9 02.8	5.1	10 53.8	4 08.1	45.7		
R	Reflected	11 55.8	8.9	10 57.6	4 17.0	40.6	+0.2	30.2
R	Direct	12 59.3	10.5	10 59.3	4 40.0	19.3		
D	Reflected	19 04.6	22.7	11 11.4	4 32.1	39.3	+0.1	34.7
D	Direct	20 17.0	25.6	11 14.4	4 44.4	30.0		
D	Direct	21 07.3	27.8	11 16.6	4 45.5	31.0	0.0	28.2
D	Reflected	22 13.3	30.8	11 19.5	4 54.0	25.5		
D	Direct	24 32.6	37.5	11 26.3	4 56.2	30.1	0.0	30.0
D	Reflected	25 32.5	40.6	11 29.4	4 59.4	30.0		
D	Reflected	28 16.5	49.8	11 38.6	5 11.9	26.6	−0.1	29.4
D	Direct	+ 29 21.4	+53.2	11 41.9	−5 09.8	32.1		
	Mean							178 06 33.8
	Correction for aberration							+0.3
	Azimuth at observatory, Sault Ste. Marie, to △ azimuth							178 06 34.1

Azimuth at observatory, Sault Ste. Marie, Mich., E. E. Haskell, observer—Continued.

[Star, date, etc.: Polaris near western elongation. March 8, 1894, $\alpha = 1^h\ 18^m\ 53^s.09$; $\delta = 88°\ 44'\ 49''.41$; $A_e = 178°\ 10'\ 45''.96$.]

Tel.	Vision.	Time from elongation.	Reduction to elongation.	Azimuth of star.	Angle between star and △ azimuth.	Azimuth of star plus the angle.	Correction for level.	Means—azimuth of △ azimuth.
		m. s.	″	° ′ ″	′ ″	° ′ ″	″	° ″
D	Reflected......	−35 36.7	+79.5	178 12 05.4	−5 35.5	178 06 29.9	−0.2	178 06 39.9
D	Direct..........	34 02.7	72.6	11 58.6	5 08.3	50.3		
D	Direct..........	32 57.7	68.0	11 54.0	5 04.8	49.2	−0.2	37.6
D	Reflected......	31 54.2	63.7	11 49.7	5 23.4	26.3		
D	Direct..........	29 16.4	53.4	11 39.4	4 41.9	57.5	−0.2	44.4
D	Reflected......	27 56.9	48.7	11 34.6	5 02.8	31.8		
D	Reflected......	24 45.2	38.2	11 24.2	4 54.7	29.5	−0.2	39.1
D	Direct..........	23 32.2	34.5	11 20.5	4 31.5	49.0		
R	Reflected......	17 17.3	18.6	11 04.6	4 29.0	35.6	0.0	35.0
R	Direct..........	15 54.2	15.8	11 01.7	4 27.5	34.2		
R	Direct..........	14 42.2	13.5	10 59.4	4 23.5	36.0	0.0	37.5
R	Reflected......	13 26.0	11.3	10 57.2	4 18.2	39.0		
R	Direct..........	11 08.9	7.8	10 53.7	4 22.8	30.9	0.0	32.9
R	Reflected......	9 59.7	6.2	10 52.2	4 17.3	34.9		
R	Reflected......	7 04.4	3.1	10 49.1	4 14.5	34.6	0.0	34.0
R	Direct..........	−5 49.7	2.1	10 48.1	4 14.8	33.3		
R	Reflected......	+5 33.3	1.9	10 47.9	3 57.9	50.0	+0.2	39.6
R	Direct..........	6 52.9	3.0	10 48.9	4 20.0	28.9		
R	Direct..........	8 03.1	4.0	10 50.0	4 20.9	29.1	+0.2	39.6
R	Reflected......	9 20.8	5.4	10 51.4	4 01.7	49.7		
R	Direct..........	12 10.7	9.2	10 55.2	4 27.0	28.2	+0.2	38.2
R	Reflected......	13 17.4	11.0	10 57.0	4 09.2	47.8		
R	Reflected......	16 28.1	16.9	11 02.9	4 13.2	49.7	+0.2	38.7
R	Direct..........	17 38.6	19.4	11 05.4	4 36.1	29.3		
D	Reflected......	24 24.2	37.1	11 23.1	4 40.4	42.7	0.0	40.8
D	Direct..........	26 02.6	42.3	11 28.2	4 49.2	39.0		
D	Direct..........	26 58.8	45.4	11 31.3	4 52.5	38.8	0.0	40.6
D	Reflected......	27 54.1	48.5	11 34.5	4 52.2	42.3		
D	Direct..........	30 38.3	58.8	11 44.7	5 09.4	35.3	0.0	36.8
D	Reflected......	31 47.7	63.3	11 49.3	5 11.1	38.3		
D	Reflected......	35 43.3	80.0	12 05.9	5 20.8	45.1	0.0	44.4
D	Direct..........	+36 55.6	+85.5	12 11.4	−5 27.7	43.7		
	Mean..							178 06 38.7
	Correction for aberration..							+0.3
	Azimuth at observatory, Sault Ste. Marie, to △ azimuth..........							178 06 39.0

[Star, date, etc.: Polaris near western elongation. March 14, 1894, $\alpha = 1^h\ 18^m\ 50^s.76$; $\delta = 88°\ 44'\ 47''.79$; $A_e = 178°\ 10'\ 44''.14$.]

Tel.	Vision.	Time from elongation.	Reduction to elongation.	Azimuth of star.	Angle between star and △ azimuth.	Azimuth of star plus the angle.	Correction for level.	Means—azimuth of △ azimuth.
D	Reflected......	−32 15.2	+65.2	178 11 49.3	−5 18.1	178 06 31.2	−0.2	178 06 42.0
D	Direct..........	30 14.6	57.3	41.5	4 48.2	53.2		
D	Direct..........	29 13.0	53.1	37.3	4 43.0	54.2	−0.2	41.2
D	Reflected......	28 09.4	49.4	33.6	5 04.8	28.7		
D	Direct..........	25 27.2	40.4	24.6	4 32.2	52.3	−0.2	40.6
D	Reflected......	24 17.3	36.8	20.9	4 51.5	29.4		
D	Reflected......	20 10.0	25.4	09.5	4 39.6	29.9	−0.2	40.0
D	Direct..........	19 07.6	22.8	07.0	4 16.4	50.5		
R	Reflected......	12 05.2	9.1	10 53.2	4 02.1	51.1	+0.2	38.0
R	Direct..........	10 48.6	7.3	51.4	4 26.9	24.5		
R	Direct..........	9 52.3	5.8	50.0	4 27.2	22.7	+0.2	37.0
R	Reflected......	8 54.6	5.0	49.1	3 58.2	50.9		
R	Direct..........	6 29.4	2.6	46.8	4 29.2	17.5	+0.3	34.3
R	Reflected......	4 37.2	1.3	45.5	3 54.8	50.6		
R	Reflected......	−55.8	0.0	44.2	3 52.0	52.2	+0.2	37.0
R	Direct..........	+14.6	0.0	44.1	4 22.8	21.3		
R	Reflected......	5 04.8	1.6	45.8	3 54.6	51.1	+0.2	38.4
R	Direct..........	6 09.8	2.4	46.5	4 21.3	25.2		
R	Direct..........	7 08.3	3.2	47.3	4 18.1	29.2	+0.2	40.0
R	Reflected......	8 29.5	4.5	47.6	3 58.1	50.5		

Azimuth at observatory, Sault Ste. Marie, Mich., E. E. Haskell, observer—**Continued.**

[Star, date, etc.: Polaris near western elongation. March 14, 1894, $\alpha = 1^h\ 18^m\ 50^s.76$; $\delta = 88°\ 44'\ 47''.79$; $A_e = 178°\ 10'\ 44''.14$.]

Tel.	Vision.	Time from elongation.	Reduction to elongation.	Azimuth of star.	Angle between star and △ azimuth.	Azimuth of star plus the angle.	Correction for level.	Means—azimuth of △ azimuth
		m. s.	″	° ′ ″	′ ″	° ′ ″	″	° ′ ″
R	Direct	−10 39.2	+ 7.1	178 10 51.2	−4 27.3	178 06 23.9	+0.2	178 06 39.5
R	Reflected	11 50.5	8.8	52.9	3 58.2	54.7		
R	Reflected	14 24.0	12.9	57.1	3 57.9	59.1	+0.3	41.9
R	Direct	15 33.5	15.1	59.2	4 35.0	24.2		
D	Reflected	22 20.9	31.2	11 15.3	4 40.9	34.4	−0.1	42.1
D	Direct	23 24.1	34.2	18.3	4 28.4	49.9		
D	Direct	24 25.8	37.2	21.4	4 35.9	45.4	0.0	42.0
D	Reflected	25 16.6	39.8	24.0	4 45.4	38.6		
D	Direct	27 39.9	47.7	31.9	4 42.8	49.0	−0.1	42.9
D	Reflected	29 01.3	52.6	36.8	4 59.9	36.9		
D	Reflected	31 53.2	63.7	47.8	5 06.3	41.5	−0.1	45.6
D	Direct	+32 59.5	+68.2	52.3	−5 02.4	49.9		
	Mean							178 06 40.1
	Correction for aberration							+0.3
	Azimuth at observatory, Sault Ste. Marie, to △ azimuth							178 06 40.4

[Star, date, etc. Polaris near western elongation. March 19, 1894, $\alpha = 1^h\ 18^m\ 48^s.61$; $\delta = 88°\ 44'\ 46''.$[illegible]; $A_e = 178°\ 10'\ 42''.25$.]

Tel.	Vision.	Time from elongation.	Reduction to elongation.	Azimuth of star.	Angle between star and △ azimuth.	Azimuth of star plus the angle.	Correction for level.	Means—azimuth of △ azimuth
D	Reflected	−19 52.6	+24.7	178 11 07.0	−4 37.9	178 06 29.0	−0.2	178 06 44.8
D	Direct	18 47.8	22.1	11 04.4	4 03.4	07 00.9		
D	Direct	17 40.8	19.5	11 01.8	4 07.0	06 54.8	−0.2	40.5
D	Reflected	16 38.7	17.3	10 59.6	4 33.0	06 26.6		
D	Direct	13 53.9	12.1	10 54.4	3 57.7	06 56.6	−0.2	41.7
D	Reflected	12 26.3	9.7	10 51.9	4 24.7	06 27.2		
D	Reflected	9 13.8	5.3	10 47.6	4 18.8	06 28.8	−0.2	46.2
D	Direct	7 56.8	3.9	10 46.2	3 42.1	07 04.1		
R	Reflected	− 0 53.4	0.0	10 42.3	4 00.4	06 41.9	0.0	38.6
R	Direct	+ 0 11.3	0.0	10 42.2	4 07.1	06 35.2		
R	Direct	1 04.2	0.1	10 42.3	4 00.3	06 42.0	0.0	41.4
R	Reflected	2 07.4	0.3	10 42.5	4 01.7	06 40.8		
R	Direct	4 48.8	1.4	10 43.7	4 10.0	06 38.7	0.0	34.6
R	Reflected	5 49.5	2.1	10 44.4	4 09.0	06 35.4		
R	Reflected	9 22.9	5.5	10 47.8	4 07.3	06 40.4	0.0	40.8
R	Direct	10 26.2	6.8	10 49.0	4 07.7	06 41.3		
R	Reflected	12 50.3	10.3	10 52.6	4 13.2	06 39.4	0.0	42.2
R	Direct	13 48.4	11.9	10 54.2	4 09.2	06 45.0		
R	Direct	14 22.2	12.9	10 55.2	4 17.4	06 37.8	0.0	38.1
R	Reflected	15 33.5	15.1	10 57.4	4 19.0	06 38.4		
R	Direct	18 08.6	20.5	11 02.8	4 24.3	06 38.4	0.0	39.0
R	Reflected	19 07.5	22.8	11 05.0	4 25.5	06 39.6		
R	Reflected	22 03.2	30.3	11 12.6	4 28.3	06 44.3	0.0	41.8
R	Direct	23 03.5	33.2	11 15.4	4 36.1	06 39.4		
D	Reflected	29 27.3	54.1	11 36.4	4 54.2	06 42.2	0.0	44.8
D	Direct	30 21.1	57.2	11 39.5	4 52.0	06 47.5		
D	Direct	31 20.8	60.4	11 42.6	4 53.9	06 48.8	−0.1	45.1
D	Reflected	32 15.3	63.5	11 45.8	5 04.5	06 41.3		
	Direct	34 10.1	70.0	11 52.3	5 03.5	06 48.8	−0.1	44.3
	Reflected	35 06.6	73.5	11 55.7	5 15.7	06 40.0		
	Reflected	38 04.1	84.9	12 07.2	5 37.6	06 29.6	−0.1	36.1
	Direct	+39 00.0	+88.8	12 11.0	−5 28.3	06 42.7		
	Mean							178 06 41.2
	Correction for aberration							+0.3
	Azimuth at observatory, Sault Ste. Marie, to △ azimuth							178 06 41.5

Azimuth at observatory, Sault Ste. Marie, Mich., E. E. Haskell, observer—Continued.

[Star, date etc.: 51 Cephei, near western elongation. March 19, 1894. $\alpha = 6^h\ 50^m\ 59.82^s$. $\delta = 87^\circ\ 13'\ 14.15''$. $A_e = 175^\circ\ 57'\ 37''.30$.]

Tel.	Vision.	Time from elongation.	Reduction to elongation.	Azimuth of star.	Angle between star and △ azimuth.	Azimuth of star plus the angle.	Correction for level.	Means—azimuth of △ azimuth.
		m. s.	″	° ′ ″	° ′ ″	° ′ ″	″	° ′ ″
D	Reflected	—25 38.6	+91.1	175 59 08.4	2 07 23.7	178 06 32.1	—0.2	178 06 37.5
D	Direct	23 59.9	79.8	58 57.1	07 56.2	06 53.3		
D	Direct	22 17.6	68.8	58 46.1	08 00.3	06 46.4	—0.2	36.6
D	Reflected	20 42.8	59.5	58 36.8	07 50.3	06 27.1		
D	Direct	17 42.1	43.4	58 30.7	08 34.5	07 05.2	—0.3	44.9
D	Reflected	15 45.1	34.4	58 11.7	08 13.6	06 25.3		
D	Reflected	11 54.2	19.6	57 56.9	08 41.9	06 38.8	—0.1	44.9
D	Direct	—10 48.6	16.2	57 53.5	08 57.6	06 51.1		
R	Reflected	[+2 21.2	0.8	57 38.1	09 07.1	06 45.2	+0.2	35.2
R	Direct	3 23.9	1.8	57 39.1	08 45.6	06 24.7		
R	Direct	4 50.8	3.3	57 40.6	08 51.4	06 32.0	+0.1	39.6
R	Reflected	[+8 55.4	+11.0	57 48.3	08 58.7	06 47.0		
	Mean							178 06 39.8
	Correction for aberration							+ 0.3
	Azimuth at observatory at Sault Ste. Marie to △ azimuth							178 06 40.1
	Mean adopted azimuth at observatory Sault Ste. Marie to △ azimuth							178 06 38.7

For the various nights the mean results are as follows: The weighted mean is obtained by weighting according to the number of results.

Azimuth of line Observatory Sault Ste. Marie to △ Azimuth.

1894.		Azimuth.	No. of results.
		° ′ ″	
Mar. 2	Polaris western elongation	178 06 34.1	16
Mar. 8	......do	178 06 39.0	16
Mar. 14	......do	178 06 40.4	16
Mar. 19	......do	178 06 41.5	16
Mar. 19	51 Cephei western elongation	178 06 40.2	6
	Weighted mean	178 06 38.87	....

The azimuth is reckoned from the south around by the west.

The result of the observations gives as the adopted azimuth for the line Observatory Sault Ste. Marie to station azimuth 178° 06′ 38.87″.

LATITUDE STAR LIST.

A list of 106 pairs of latitude stars has been prepared, suitable for observations at Sault Ste. Marie. It includes pairs of stars throughout the whole range of right ascension from 0 to 24 hours, and is suited for the determination of latitude at any time of the year. The list includes 81 stars from the Berlin Jahrbuch catalogue of 622 stars; 81 stars from Safford's catalogue of 2,018 stars; 6 from the Northern Boundary Survey catalogue of 500 stars; 24 from H. Romberg's catalogue of 5,634 stars observed at Pulkowa Observatory from the years 1874 to 1880, and 20 stars from the Coast Survey catalogue of 2,179 stars, report of 1876. The various catalogues are indicated by the abbreviations B. J., S., N. B., R., and C. S. The square brackets around a B. J. star [ ] indicate it is a star for which the day places are not given in the Berlin Jahrbuch. The star factors for such stars, however, are given by which the day places can be readily computed.

The following is the list of latitude pairs. The settings given have a correction for refraction applied:

Latitude list for Sault Ste. Marie, Mich.

No. of pair.	Catalogue.	Star.	Magnitude.	Mean A. R., 1895.	Mean declination, 1895.	Zenith distance.	Setting.	
				h. m. s.	° ′ ″	° ′ ″	° ′	
1	B. J.	[22 Andromedæ]	5.6	0 04 51.78	45 29 15.82	S. 1 00 50	0 56.2	S.
	S.	1743 C	6.0	0 11 36.40	47 21 46.30	N. 0 51 40		N.
2	N. B.	5	5.5	0 15 35.34	37 23 13.02	S. 9 06 53	9 25.0	S.
	S.	1764 A	6.5	0 20 54.49	56 03 36.10	N. 9 33 30		N.
3	B. J.	[χ Cassiopeæ]	4.3	0 27 01.89	62 21 07.49	N. 15 51 01	16 01.7	N.
	B. J.	δ Andromedæ	3.3	0 33 42.77	30 17 11.25	S. 16 12 55		S.
4	S.	1816 B	6.0	0 39 18.08	54 38 46.50	N. 8 08 40	8 22.3	N.
	B. J.	μ Andromedæ	4.0	0 50 55.54	37 55 47.52	S. 8 34 18		S.
5	S.	1862 C	6.7	0 59 44.53	62 12 00.60	N. 15 41 55	15 22.2	N.
	S.	1870 B	6.0	1 02 14.51	31 27 05.40	S. 15 03 05		S.
6	B. J.	β Andromedæ	2.3	1 03 51.14	35 03 50.32	S. 11 26 16	11 18.3	S.
	S.	1899 B 2d	5.6	1 13 28.54	57 40 47.00	N. 11 10 41		N.
7	S.	1915 B	5.0	1 21 22.20	44 51 52.16	S. 1 38 14	1 37.0	S.
	B. J.	ν Persei	3.6	1 31 32.75	48 05 46.16	N. 1 35 40		N.
8	S.	1949 C	6.0	1 34 21.59	42 46 01.50	S. 3 44 04	3 45.1	S.
	N. B.	40	6.0	1 45 28.40	50 16 27.44	N. 3 46 21		N.
9	B. J.	α Trianguli	3.6	1 47 05.72	29 04 01.95	S. 17 26 04	17 24.2	S.
	N. B.	45	3.6	1 55 13.70	63 52 59.99	N. 17 22 54		N.
10	B. J.	γ Andromedæ	2.4	1 57 27.14	41 49 32.54	S. 4 40 34	4 22.5	S.
	B. J.	[6 Persei]	6.0	2 06 37.21	50 34 40.09	N. 4 04 34		N.
11	R.	563	6.5	2 14 55.30	44 07 07.56	S. 2 22 58	2 42.3	S.
	R.	572	5.8	2 17 26.13	49 31 48.16	N. 3 01 42		N.
12	B. J.	[ι Cassiopeæ]	4.1	2 20 24.83	66 55 48.19	N. 20 25 43	20 09.2	N.
	R.	627	5.9	2 34 32.83	26 36 35.52	S. 19 53 30		S.
13	B. J.	[η Persei]	3.6	2 43 02.20	55 27 33.32	N. 8 57 28	8 46.4	N.
	R.	679	6.0	2 47 04.98	37 54 34.00	S. 8 35 32		S.
14	B. J.	γ Persei	3.0	2 57 11.41	53 05 42.14	N. 6 35 36	6 13.2	N.
	B. J.	β Persei [2]	var.	3 01 20.10	40 33 03.24	S. 5 57 04		S.
15	C. S.	289	4.9	3 12 10.00	33 50 13.30	S. 12 39 53	12 51.9	S.
	B. J.	2 H Camelop	4.6	3 20 33.91	59 34 27.07	N. 13 04 21		N.
16	B. J.	[σ Persei]	4.8	3 23 10.24	47 37 56.92	N. 1 07 50	1 23.1	N.
	C. S.	315	5.5	3 25 10.00	45 42 02.55	S. 1 48 03		S.
17	B. J.	[ο Persei]	4.0	3 37 43.95	31 57 19.15	S. 14 32 47	14 20.1	S.
	B. J.	9 H. Camelop	6.0	3 48 10.98	60 48 03.82	N. 14 17 58		N.
18	R.	909	5.0	3 55 42.12	58 51 48.36	N. 12 21 42	12 16.3	N.
	B. J.	[54 Persei]	5.8	4 13 35.48	34 18 46.21	S. 12 11 20		S.
19	R.	993	6.3	4 17 48.89	33 43 03.04	S. 12 47 03	12 47.8	S.
	R.	1057	6.9	4 34 12.28	59 19 10.46	N. 12 49 04		N.
20	B. J.	4 Camelop	5.8	4 39 15.28	56 34 12.69	N. 10 04 07	10 01.2	N.
	C. S.	477	5.0	4 45 36.00	36 31 33.35	S. 9 58 33		S.
21	B. J.	ι Aurigæ	3.0	4 50 09.33	32 59 58.47	S. 13 30 08	13 38.5	S.
	B. J.	10 Camelop	4.0	4 54 04.67	60 17 17.78	N. 13 47 12		N.
22	R.	1136 1st	6.0	4 57 03.93	58 49 30.36	N. 12 19 24	12 31.3	N.
	R.	1146	7.0	4 59 14.51	33 46 27.08	S. 12 43 39		S.
23	C. S.	505	5.4	5 01 35.00	20 16 46.75	N. 26 13 19	26 25.6	N.
	C. S.	513	5.7	5 05 16.00	73 08 50.80	S. 26 38 45		S.
24	C. S.	530	5.8	5 14 32.00	29 27 40.15	S. 17 02 26	16 45.2	S.
	B. J.	17 Camelop	6.0	5 20 15.14	62 58 44.20	N. 16 28 38		N.
25	C. S.	553	5.8	5 27 58.00	54 21 30.70	N. 7 51 25	7 36.3	N.
	C. S.	573	4.7	5 41 54.00	39 08 40.15	S. 7 21 26		S.
26	B. J.	[ν Aurigæ]	4.0	5 44 12.64	39 07 02.64	S. 7 23 03	7 34.6	S.
	B. J.	ζ Aurigæ	4.1	5 50 52.85	54 16 34.31	N. 7 46 28		N.
27	C. S.	604	4.9	5 57 45.00	23 16 08.15	S. 23 13 58	23 02.2	S.
	B. J.	22 H. Camelop	4.6	6 07 16.52	69 21 22.44	N. 22 51 16		N.

Latitude list for Sault Ste. Marie, Mich.—Continued.

No. of pair.	Catalogue.	Star.	Magnitude.	Mean A. R., 1895.	Mean declination, 1895.	Zenith distance.	Setting.	
				h. m. s.	° ′ ″	° ′ ″	° ′	
28	B. J.	ψ^1 Aurigæ	5.1	6 16 48.74	49 20 27.80	N. 2 50 22	2 49.7	N.
	B. J.	[ψ^5 Aurigæ]	5.8	6 39 10.21	43 40 53.50	S. 2 49 12		S.
29	B. J.	θ Geminorum	3.3	6 45 52.16	34 05 15.53	S. 12 24 51	12 14.0	S.
	B. J.	15 Lyncis	4.7	6 48 11.14	58 33 35.99	N. 12 03 30		N.
30	C. S.	697	5.7	7 08 05.00	47 25 39.35	N. 0 55 33	1 00.2	N.
	C. S.	702	6.0	7 13 41.00	45 25 19.75	S. 1 04 46		S.
31	C. S.	705	5.3	7 15 02.00	36 57 30.10	S. 9 32 36	9 30.7	S.
	C. S.	728	6.0	7 28 15.00	55 59 11.75	N. 9 29 06		N.
32	B. J.	24 Lyncis	5.1	7 34 07.43	58 57 20.03	N. 12 27 14	12 38.3	N.
	B. J.	π Geminorum	5.3	7 40 44.26	33 40 23.47	S. 12 49 43		S.
33	R.	1767	6.5	7 44 17.45	33 29 52.46	S. 13 00 14	12 54.8	S.
	R.	1787	6.6	7 52 32.54	59 19 54.58	N. 12 49 49		N.
34	N. B.	132	5.0	8 02 22.20	68 46 59.17	N. 22 16 53	22 12.5	N.
	R.	1866	6.2	8 14 17.61	24 21 10.22	S. 22 08 56		S.
35	C. S.	787	5.6	8 20 27.00	27 16 39.90	S. 19 13 26	19 06.4	S.
	C. S.	791	5.4	8 25 13.00	65 30 09.85	N. 19 00 04		N.
36	B. J.	[Gr. 1446]	6.0	8 28 01.85	73 59 46.94	N. 27 29 41	27 43.2	N.
	B. J.	δ Cancri	4.0	8 38 43.09	18 32 24.29	S. 27 57 42		S.
37	R.	1967	5.7	8 44 43.50	62 21 17.52	N. 15 51 12	15 41.1	N.
	B. J.	[σ^2 Cancri m]	5.8	8 47 50.34	30 58 36.49	S. 15 31 30		S.
38	B. J.	[ρ Urs. Maj.]	5.0	8 53 04.69	68 02 18.72	N. 21 32 12	21 34.8	N.
	R.	2009	5.6	8 56 36.02	24 51 57.78	S. 21 38 08		S.
39	B. J.	σ^2 Urs. Maj	5.0	9 01 09.33	67 33 38.07	N. 21 03 32	20 58.1	N.
	R.	2082	7.1	9 15 04.11	25 36 43.66	S. 20 53 22		S.
40	B. J.	θ Urs. Maj.	3.0	9 25 50.13	52 09 19.95	N. 5 39 15	5 57.5	N.
	R.	2155	5.8	9 35 30.03	40 14 10.58	S. 6 15 55		S.
41	B. J.	υ Urs. Maj.	3.6	9 43 31.45	59 31 57.27	N. 13 01 51	13 19.3	N.
	R.	2199	6.4	9 50 21.80	32 52 53.92	S. 13 37 12		S.
42	R.	2207	5.0	9 52 38.22	57 18 50.12	N. 10 48 44	10 46.5	N.
	R.	2232	4.4	10 01 14.28	35 45 22.92	S. 10 44 43		S.
43	B. J.	ζ Leonis	3.0	10 10 51.04	23 56 26.17	S. 22 33 39	22 39.6	S.
	C. S.	914	5.8	10 13 03.00	69 16 30.20	N. 22 46 24		N.
44	R.	2273	6.9	10 18 03.21	34 43 29.00	S. 11 46 37	11 26.8	S.
	B. J.	[37 Urs. Maj.]	5.1	10 28 23.86	57 37 24.23	N. 11 07 18		N.
45	B. J.	[35 H. Urs. Maj.]	5.1	10 35 33.10	69 37 30.62	N. 23 07 25	22 56.2	N.
	B. J.	[41 Leonis min.]	5.3	10 37 42.42	23 44 16.98	S. 22 45 49		S.
46	C. S.	952	5.9	10 46 15.00	53 03 46.70	N. 6 33 41	6 38.5	N.
	C. S.	963	5.1	10 54 58.00	39 46 34.25	S. 6 43 32		S.
47	R.	2400	6.5	10 55 54.34	59 13 52.62	N. 12 43 47	12 46.7	N.
	B. J.	ν Urs. Maj	3.3	11 12 48.62	33 40 02.24	S. 12 50 04		S.
48	B. J.	Gr. 1771	6.1	11 16 36.64	64 54 18.10	N. 18 24 12	18 16.0	N.
	R.	2529	6.6	11 30 46.40	28 21 40.48	S. 18 08 26		S.
49	C. S.	1010	5.5	11 49 19.00	56 22 45.80	N. 9 52 40	9 51.5	N.
	R.	2615	5.5	11 56 17.22	36 37 46.20	S. 9 52 20		S.
50	B. J.	[2 Can. Ven.]	5.9	12 10 51.92	41 14 41.18	S. 5 15 25	5 26.9	S.
	S.	33 A	5.6	12 18 55.17	52 08 37.50	N. 5 38 32		N.
51	B. J.	[74 Urs. Maj.]	5.6	12 25 03.21	58 59 00.66	N. 12 28 55	12 34.5	N.
	S.	61 A	5.6	12 28 28.70	33 49 40.70	S. 12 40 25		S.
52	S.	95 A	5.6	12 45 11.72	38 05 16.80	S. 8 24 49	8 17.2	S.
	S.	108 A	6.7	12 51 40.81	54 40 03.28	N. 8 09 57		N.
53	S.	121 A	6.0	12 57 40.82	64 10 26.80	N. 17 40 21	17 52.6	N.
	B. J.	43 Comae	4.1	13 06 58.45	28 24 37.62	S. 18 05 27		S.
54	S.	157 A	6.0	13 19 08.25	37 34 55.90	S. 8 55 10	8 58.4	S
	S.	161 A	5.0	13 21 01.00	55 32 05.34	N. 9 01 59		N.

Latitude list for Sault Ste. Marie, Mich.—**Continued.**

No. of pair.	Catalogue.	Star.	Magnitude.	Mean A. R., 1895.	Mean declination, 1895.	Zenith distance.		Setting.	
				h. m. s.	° ′ ″		° ′ ″	° ′	
55	B. J.	17 H. Can. Ven	5.5	13 30 06.45	37 43 13.15	S.	8 46 53	8 44.6	S.
	S.	193 A	5.6	13 36 45.40	55 12 45.84	N.	8 42 40		N.
56	B. J.	[ι Draconis]	5.0	13 48 21.92	65 14 20.93	N.	18 44 25	18 36.7	N.
	S.	232 A	5.0	13 51 46.60	28 00 25.10	S.	18 29 41		S.
57	B. J.	11 Bootis	6.0	13 56 24.84	27 53 37.81	S.	18 36 28	18 29.2	S.
	B. J.	α Draconis	3.3	14 01 32.77	64 52 39.87	N.	18 22 34		N.
58	S.	271 B	6.0	14 12 08.52	40 13 53.10	S.	6 16 13	6 03.0	S.
	B. J.	θ Bootis	3.8	14 21 37.32	52 20 10.07	N.	5 50 03		N.
59	S.	309 A	6.7	14 31 23.11	65 51 13.90	N.	19 21 08	19 26.0	N.
	S.	320 A	5.0	14 38 48.45	26 58 27.82	S.	19 31 38		S.
60	B. J.	Gr. 2164	5.8	14 48 46.45	59 43 15.35	N.	13 13 10	13 29.7	N.
	R.	3319	6.5	14 51 37.98	32 43 28.14	S.	13 46 38		S.
61	S.	361 A	6.0	15 02 21.73	66 19 36.90	N.	19 49 31	19 48.4	N.
	S.	363 A	6.0	15 03 51.78	26 42 11.64	S.	19 47 54		S.
62	S.	386 A	5.6	15 17 36.36	33 18 34.04	S.	13 11 32	13 00.5	S.
	B. J.	ι Draconis	3.0	15 22 35.57	59 20 02.43	N.	12 49 56		N.
63	S.	405 A	6.7	15 25 52.40	61 01 56.30	N.	14 31 50	14 39.3	N.
	B. J.	[θ Cor. Bor.]	4.0	15 28 41.62	31 42 48.72	S.	14 47 17		S.
64	B. J.	[φ Bootis]	5.0	15 34 03.39	40 41 42.77	S.	5 48 23	5 59.8	S.
	S.	444 A	6.5	15 39 59.17	52 41 31.50	N.	6 11 26		N.
65	S.	470 A	6.0	15 51 58.36	38 15 00.34	S.	8 15 06	8 23.8	S.
	B. J.	[Gr. 2296]	5.1	15 55 17.76	55 02 47.00	N.	8 32 40		N.
66	S.	479 A	6.5	15 57 01.90	33 37 12.42	S.	12 52 54	12 36.6	S.
	B. J.	θ Draconis	3.6	15 59 55.41	58 50 44.66	N.	12 20 39		N.
67	S.	500 B	6.7	16 06 59.49	58 12 39.90	N.	11 42 34	12 02.4	N.
	S.	506 A	6.5	16 10 44.66	34 07 29.90	S.	12 22 36		S.
68	S.	516 A	6.0	16 15 30.09	60 00 33.30	N.	13 30 27	13 42.7	N.
	S.	521 A	6.7	16 18 54.64	32 34 41.50	S.	13 55 24		S.
69	B. J.	η Draconis	2.6	16 22 34.42	61 45 06.87	N.	15 15 00	15 30.7	N.
	S.	549 A	6.0	16 29 23.60	30 43 09.43	S.	15 46 57		S.
70	S.	553 B	6.0	16 30 56.39	61 02 35.10	N.	14 32 29	14 37.3	N.
	B. J.	[ζ Herculis]	2.6	16 37 19.73	31 47 35.41	S.	14 42 30		S.
71	S.	585 B	5.0	16 46 09.52	46 09 58.06	S.	0 20 08	0 16.3	S.
	S.	597 B	6.7	16 51 18.02	46 42 32.70	N.	0 12 27		N.
72	S.	609 A	6.7	16 57 26.00	56 50 33.10	N.	10 20 27	10 23.0	N.
	S.	625 A	6.5	17 04 18.74	36 04 17.90	S.	10 25 48		S.
73	N. B.	297	6.0	17 05 46.90	55 54 05.08	N.	9 23 59	9 29.1	N.
	B. J.	π Herculis	3.1	17 11 23.37	36 55 38.90	S.	9 34 27		S.
74	S.	643 A	5.4	17 14 02.09	37 24 05.00	S.	9 06 01	8 55.5	S.
	B. J.	[ν¹ Draconis]	4.7	17 30 06.54	55 15 21.69	N.	8 45 16		N.
75	S.	659 A	4.0	17 20 03.79	37 14 32.66	S.	9 15 23	8 59.9	S.
	B. J.	[ν² Draconis]	4.7	17 30 11.90	55 14 40.22	N.	8 44 34		N.
76	S.	687 A	6.5	17 33 54.39	61 57 17.14	N.	15 27 11	15 20.6	N.
	S.	689 A	6.0	17 35 59.55	31 15 28.50	S.	15 14 28		S.
77	B. J.	o Herculis	3.8	18 03 26.79	28 44 53.09	S.	17 45 13	17 48.1	S.
	B. J.	[36 Draconis]	5.0	18 13 17.46	64 21 41.60	N.	17 51 36		N.
78	S.	766 A	6.7	18 15 53.76	68 43 04.40	N.	22 12 58	22 27.2	N.
	S.	784 A	6.0	18 25 14.49	23 47 46.80	S.	22 42 19		S.
79	S.	789 B	6.5	18 28 49.22	30 28 31.54	S.	16 01 34	15 58.4	S.
	S.	809 C	6.0	18 36 37.00	02 25 48.70	N.	15 55 43		N.
80	B. J.	[ε Lyræ a pr]	4.5	18 40 51.57	39 33 37.34	S.	6 56 29	6 39.2	S.
	S.	329 A	6.0	18 44 22.26	52 52 21.50	N.	6 22 16		N.

Latitude list for Sault Ste. Marie, Mich.—Continued.

No. of pair.	Catalogue.	Star.	Magnitude.	Mean A. R., 1895.	Mean declination, 1895.	Zenith distance.	Setting.	
				h. m. s.	° ′ ″	° ′ ″	° ′	
81	B. J.	β Lyrae	3.4–4.5	18 46 12.19	33 14 27.49	S. 13 15 38	13 00.3	S.
	B. J.	o Draconis	4.6	18 49 39.11	59 15 36.07	N. 12 45 30		N.
82	B. J.	[ι Lyræ]	5.0	19 03 33.32	35 56 08.41	S. 10 33 58	10 20.2	S.
	S.	985 A	6.5	19 09 41.43	56 36 48.10	N. 10 06 42		N.
83	B. J.	δ Draconis	3.0	19 12 31.83	67 28 36.44	N. 20 58 31	20 42.1	N.
	S.	919 A	6.5	19 18 32.85	26 03 39.12	S. 20 26 27		S.
84	S.	955 A	5.4	19 27 52.13	34 13 46.90	S. 12 16 19	12 04.1	S.
	S.	957 A	6.4	19 29 23.55	58 22 22.60	N. 11 52 17		N.
85	S.	976 A	6.7	19 33 39.66	63 12 02.20	N. 16 41 56	16 38.6	N.
	S.	977 A	5.0	19 35 13.65	29 54 10.70	S. 16 35 55		S.
86	S.	1026 B	6.0	19 49 02.00	47 39 38.45	N. 1 09 32	1 05.2	N.
	S.	1057 C	6.0	19 56 02.00	45 29 09.65	S. 1 00 56		S.
87	S.	1072 A	6.5	20 00 21.79	64 31 36.34	N. 18 01 30	18 04.2	N.
	S.	1097 A	6.0	20 09 55.69	28 22 35.80	S. 18 07 30		S.
88	S.	1115 A	5.4	20 12 13.56	47 23 29.50	N. 0 53 24	0 54.6	N.
	S.	1154 A	6.7	20 26 31.32	45 34 19.56	S. 0 55 46		S.
89	S.	1182 C	6.0	20 33 28.00	37 57 49.30	S. 8 32 17	8 50.0	S.
	N. B.	403	6.0	20 36 17.50	55 38 03.61	N. 9 07 58		N.
90	S.	1211 B	6.0	20 41 08.14	46 54 57.00	N. 0 24 51	0 35.8	N.
	S.	1226 A	6.5	20 45 21.67	45 43 27.38	S. 0 46 39		S.
91	S.	1233 A	5.6	20 49 31.91	43 59 22.3[illegible]	S. 2 30 43	2 24.0	S.
	S.	1247 B	6.7	20 52 59.72	48 47 28.44	N. 2 17 22		N.
92	S.	1256 A	6.5	20 55 08.08	50 03 14.40	N. 3 33 08	3 16.3	N.
	B. J.	[ξ Cygni]	4.0	21 01 06.72	43 30 31.86	S. 2 59 34		S.
93	S.	1280 C	6.7	21 07 14.00	62 52 01.40	N. 16 21 55	16 31.9	N.
	B. J.	ζ Cygni	3.0	21 08 28.01	29 47 46.21	S. 16 42 20		S.
94	B. J.	[τ Cygni]	4.0	21 10 35.96	37 35 50.32	S. 8 54 16	8 52.6	S.
	S.	1294 B	6.0	21 14 05.80	55 21 24.30	N. 8 51 18		N.
95	S.	1320 A	5.4	21 25 11.48	23 10 42.60	S. 23 19 23	23 27.2	S.
	B. J.	β Cephei	3.0	21 27 18.36	70 05 58.88	N. 23 35 52		N.
96	S.	1359 A	5.4	21 38 21.89	50 42 36.94	N. 4 12 31	4 04.0	N.
	S.	1377 C	6.5	21 42 06.20	42 34 31.10	S. 3 55 35		S.
97	S.	1382 C	6.0	21 44 08.00	38 09 37.60	S. 8 20 28	8 34.2	S.
	S.	1399 B	6.0	21 48 27.86	55 18 11.20	N. 8 48 05		N.
98	S.	1429 A	6.5	22 01 44.12	47 43 13.70	N. 1 13 08	1 24.0	N.
	S.	1457 A	6.0	22 09 29.00	44 55 11.10	S. 1 34 55		S.
99	S.	1474 B	5.4	22 16 41.10	46 00 26.76	S. 0 29 39	0 34.8	S.
	S.	1494 B	5.0	22 25 09.11	47 10 08.60	N. 0 40 03		N.
100	B. J.	[30 Cephei]	5.3	22 34 55.47	63 02 18.51	N. 16 32 12	16 40.7	N.
	B. J.	η Pegasi	3.0	22 38 04.79	29 40 19.35	S. 16 49 47		S.
101	B. J.	ι Cephei	3.4	22 45 56.46	65 38 52.94	N. 19 08 47	19 03.7	N.
	B. J.	β Pegasi	var.	22 58 41.00	27 30 47.28	S. 18 59 18		S.
102	S.	1589 B	6.7	23 02 58.92	48 43 24.90	N. 2 13 19	2 03.8	N.
	S.	1609 B	6.0	23 12 19.68	44 35 33.20	S. 1 54 13		S.
103	S.	1628 A	6.0	23 16 47.20	31 14 13.40	S. 15 15 53	15 13.8	S.
	B. J.	4 Cassiop	5.8	23 20 10.36	61 42 22.34	N. 15 12 17		N.
104	S.	1649	6.5	23 28 13.00	21 55 10.45	S. 24 34 56	24 33.8	S.
	C. S.	2138	6.0	23 30 24.00	71 03 42.35	N. 24 33 36		N.
105	S.	1661 B	6.5	23 34 02.75	49 53 25.28	N. 3 23 19	3 04.1	N.
	B. J.	[χ Androm]	4.1	23 35 14.15	43 45 09.00	S. 2 44 57		S.
106	B. J.	41 H. Cephei	5.6	23 42 53.21	67 13 24.18	N. 20 43 18	20 26.3	N.
	S.	1707 A	6.5	23 55 01.33	26 20 07.06	S. 20 09 59		S.

The list of latitude pairs has been prepared with a view to observing latitude from time to time, for the purpose of detecting the change of latitude, if there is any. Recent determinations of latitude at various points over the surface of the earth by skilled observers and the elaborate investigations of the older observations of latitude and star declinations leave little doubt that there is a change of latitude with a period of about one year, and the amplitude of which is about 0''.6. Two places on the earth's surface, 180° apart in longitude, show these small changes of latitude exactly opposite in phase. At Greenwich, for instance, when the latitude is at its greatest, at Honolulu it is at its least value. This would indicate that the pole of the earth describes a circle around its mean position in the period of the latitude change.

If there is any such motion of the pole there would be a corresponding change in the azimuth of a line on the earth's surface. The maximum change of azimuth will occur between the time the pole is farthest east and farthest west of its mean position, which corresponds to the time of greatest deviation of latitude from its mean position for a place 90° distant in longitude from the place of the azimuth.

Suppose the mean position or the center of the circle described by the pole to be at P on the surface of the earth and its position at its farthest west of its mean position as viewed from any other point S to be at P', then the change in the direction of the meridian through S due to the change in the position of the pole will be the angle P S P'.

The spherical triangle P S P', being right-angled at P', gives,

$$\sin. PSP' = \frac{\sin. PP'}{\sin. SP}$$

Taking for the position of the point S Sault Ste. Marie, of which the latitute is 46° 30' 06'', S P is the co-latitude, P P' is half the change of the latitude, 0''.3 for a point 90° distant in longitude and the corresponding change in direction of the meridian is at Sault Ste. Marie, 0''.44. The greatest change in the azimuth of the line will be twice the change in the direction of the meridian, or 0''.88.

To determine such a small change in the azimuth requires a very precise method of observation. The probable error of a very good measurement of a horizontal angle is about $\pm 0''.5$. The azimuth of a line determined in the usual way by means of a horizontal circle would not be any more accurate. The probable error of a latitude determination by means of the zenith telescope is only $\pm 0''.08$. The method of tracing the latitude change by observation of an azimuth would therefore not be of any great value as compared with the direct determinations of the latitude, unless some more accurate method of observing the azimuth can be devised than the one ordinarily in use.

In the ordinary method of determining the azimuth, the error is due to the errors of the circle used in observing the angle between the star and the mark, and the error due to observation of the star at an altitude, where a correction for level has to be applied for the inclination of the horizontal from observations with a striding level. The errors of graduation of the best circles are nearly of the same order as the change of azimuth to be determined.

The observatory at Sault Ste. Marie is well adapted for precise détermination of azimuth. The stone pier for mounting the instrument is large and solid and well isolated from the surface layers of the earth, so that no tremors are transmitted. There is a concrete pier for holding a mercury dish, and the star can be observed direct, and reflected from Mercury, dispensing with the use of a striding level. △ Azimuth is in the same vertical plane as Polaris at western elongation within 4', and the angle between it and the star can be determined with a micrometer, dispensing with the use of a horizontal circle.

The expression for the azimuth of a star at elongation is:

$$\sin. A = \sec. \varphi \cos. \delta.$$

A = azimuth of star.
φ = latitude of place.
δ = declination of star.

Supposing the azimuth and the latitude to vary and the declination of the star to remain constant, then differentiating the equation with respect A and φ it becomes:

$$d\,A = \frac{\cos. \delta \tan. \varphi}{\cos. A}\, d\,\varphi$$

For a change of latitude of 1'' or $d\,\varphi = 1''$ the corresponding change of azimuth of the star or $d\,A$ is 0''.033. There is, therefore, very little change of azimuth for a variation of latitude at a place. The change in the azimuth occurs, however, for a change of latitude at places 90° in longitude east and west of the place. Supposing the latitude to remain constant and the declination of the star to vary, then differentiating the equation with respect to A and δ there results:

$$d\,A = \frac{-\sec.\,\varphi \sin.\,\delta}{\cos A}\,d\,\delta$$

For Polaris, $\delta = 88^\circ\ 44'\ 55''$ and a variation of 1″ in δ or $d\,\delta = 1''$, this gives $d\,A = 1.45''$.

The standard stars used in observing azimuth, their azimuths at western elongation for Sault Ste. Marie, their declinations and right ascensions are given in the following table:

Azimuth of stars at Sault Ste. Marie, Mich.

Star.	Magnitude.	Declination, 1894.			Right ascension, 1894.			Sidereal time of western elongation.			Azimuth at western elongation.		
		°	′	″	h.	m.	s.	h.	m.	s.	°	′	″
Polaris	2	88	44	34	1	20	06	7	14	48	178	10	24
51 H. Cephei	5	87	12	48	6	50	45	12	38	59	175	57	00
6 Urs. Min	6	88	17	36	12	14	21	18	07	09	177	31	13
δ Urs. Min	4.5	86	36	44	18	06	30	23	52	11	175	04	30
λ Urs. Min	6.7	88	58	32	19	29	13	1	24	54	178	30	42

Very respectfully, your obedient servant,

THOMAS RUSSELL.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. A.

B.—REPORT OF MR. FRED MORLEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., December 15, 1893.

SIR: I have the honor to submit the following report on the primary triangulation planned in connection with the resurvey of the St. Marys River, and which extends from the old Mackinac base line on the south side of the Straits of Mackinac northward to a connection with the triangulation system of the lake survey in the eastern end of Lake Superior.

A system of triangulation for expanding from a possible 4-mile base line on Batchewana Island to the primary triangles, and forming at the same time a part of the secondary system, planned in Whitefish, Batchewana, and Goulais bays is also included.

This work, assigned to me by your letter of instructions dated April 19, 1893, was accomplished between April 17, when I reported for duty to General Poe in Detroit, and November 15, when my leave of absence from the University of Michigan expired.

Detail reports on all stations located and on the work in general having been furnished from time to time as the work progressed, as well as an annual report at the close of June, it seems unnecessary at this time to present more than a summary on the work as a whole.

In the early part of the season progress was delayed by the lateness of the spring and consequent unfavorable weather, as well as by the lack of suitable help and want of necessary instruments, and it was not until about the middle of June that these drawbacks were mainly removed. The use of only a small sailboat on the secondary work in Whitefish and adjacent bays was also a source of considerable delay. From about the middle of October to the middle of November the atmosphere continued so unfavorable for seeing as to greatly delay the work during that time.

South of Sault Ste. Marie much of the country back from the shore is quite accessible by roads, and so well settled up and provided with means of travel that little difficulty was experienced in securing accommodations and in getting from place to place. One and sometimes two men, in addition to myself, made up the party on this portion of the work.

North of Sault Ste. Marie the unsettled condition of the country made it necessary to procure a tent and other camp outfit and carry with us provisions for our subsistence. Journeys were made through the forests on foot. On two occasions Indian guides were employed. Two and, for a part of the time, three men were required in the reconnoissance of this section of country.

A field glass, a prismatic compass, a pocket sextant, creepers for climbing trees, and sectional maps of the country and charts of the lakes were provided for my use. A good aneroid barometer would frequently have been of service.

Mirrors were sometimes used in determining the intervisibility of stations by reflecting sunlight between them. The required heights of stations were most frequently determined by observations from tree tops.

THE SOUTHERN CONNECTION.

This is made on the old Mackinac base-line situated on the south side of the Straits of Mackinac and extending from McGulpins Point southeast about 4 miles. The buried stones marking the ends of this base have been found. These stones do not appear to have suffered the least change in position since they were set about forty years ago. The geodetic points on their upper surfaces, marking the exact end of the base, also appear in perfect condition. No surface marks at the ends of the base remain to indicate their location. The northwest end stone of the base is about 16 feet out in front of the front door of the McGulpin Point light-house. The southeast end stone is in the highway leading from Mackinac City to Cheboygan, and about 2 miles from the former place, as indicated by the mile post on the Michigan Central Railroad, which runs parallel to the base along its southeast portion.

A remeasurement of this base-line is recommended. The southeast end of it is now occupied by a public highway, a portion of which is but little traveled. This half presents no obstruction to measurement, and little, if any, to the intervisibility of base ends. The northwest quarter of the base is occupied by a private road leading to McGulpin Point light-house, is little traveled, offers no obstructions to measurement, and can be cleared of obstructions to sight at small expense. The remaining mile having been allowed to grow up again since it was first cut out presents obstructions to measurement as well as to sight. This portion can, however, be reopened at probably less than half the expense required in the first cutting.

The system of quadrilaterals adopted in passing northward from the Mackinac base, it will be seen, closely agrees for a ways with the system formerly used in the survey of the Straits of Mackinac. The geodetic points of the former stations on Point St. Ignace, Rabbits Back Peak, and Mackinac Island, have been recovered, but with the possibility of the last named having been slightly disturbed. These points are to be reoccupied. Lack of time and unfavorable weather prevented my visiting Boiling Spring Point, Point St. Martin, and Point Fuyard to look for former stations on these points. There is little doubt but that the stations on the first two named points can be recovered, and possibly on all three points. These stations, if found, are to be reoccupied and, if not found, new stations in their *immediate* vicinity are to be used. A line from Mackinac Island to a station near the northeast end of Bois Blanc Island being determined through the above series of stations, the triangulation will be carried northward from this line to two inland stations, and so on.

The average height of timber being about 80 feet, and the country comparatively even, high stations are required at the two inland points and near the northeast end of Bois Blanc Island to get above the timber and avoid cutting.

THE NORTHERN CONNECTION.

Of the old lake survey stations in the eastern end of Lake Superior, Mamainse, situated about 9 miles north of Batchewana Bay, was the last or most southerly station. Gargantua, located on the east coast of the lake, about 42 miles northwesterly of Mamainse, together with station Michipicoten, on the northwest side of Michipicoten Island, formed with Mamainse the vertices of the last triangle in the lateral chain of triangles in this end of the lake.

At Mamainse "the geodetic point was marked by a nail driven into a stake about 2½ inches in diameter set about one foot below the ground surface." This stake was found, and, though its top portion was rotted away so that the nail itself was not recovered in place, the main portion of the stake was so well preserved that I feel confident that the place of the original geodetic point was recovered within less than half an inch. The astronomical stone post in the vicinity is still in place.

At Gargantua "the brass point about one fourth of an inch in diameter set in the rock to mark the geodetic point" was found in place and in perfect condition. The "astronomical stone post" near by is also undisturbed. This station is on a hill only 131 feet above the lake, and unfortunately so situated that nothing can be seen from it to the eastward of the line from it to Mamainse owing to the higher hills but a short distance away on the easterly side of Gargantua Harbor. The line Mamainse-Gargantua could not, therefore, be used as at first anticipated as the direct line of connection.

The new station Pantagruel was therefore located on the higher hills about a mile from the northeast shore of Gargantua Harbor, about 2 miles eastward of station Gargantua, and the recovery of Michipicoten station sought for.

At Michipicoten the geodetic point is recorded as being "marked by a cross, cut in the solid surface rock." The tripod is still standing, though apparently tilted over southerly about 6 inches. I was unable to discover what appeared to me unmistakable marks, as described above, of the geodetic point.

"The astronomical stone post, used in 1869, bearing south 44° 04′ west and 120.25 feet distant from the geodetic point" was found undisturbed and its center marked by the intersection of three lines. These lines, though not cut very deep, were plain, especially if the rock stone post was wet.

I recommend that the "astronomical stone post" be reoccupied and observation made for true meridian whence knowing the azimuth and distance from the "stone post" to the geodetic point the latter can be relocated. A careful examination of the surface of the rock, at the point so located, with a magnifying glass, after having thoroughly washed the rock with water, may lead to the discovery of the original marks. If the original marks and consequently the geodetic point are found, the line Michipicoten-Mamainse is the line of connection to use. If no marks are found, the relocation of the geodetic point by its recorded azimuth and distance from the astronomical stone post is to be made, in which case Gargantua could be reoccupied, the angles of the triangle Michipicoten-Mamainse-Gargantua remeasured at small expense, and the line Gargantua-Mamainse still used as the line of connection. It would be well to procure a copy of the original field notes pertaining to the measurement of the distance and the determination of the azimuth between the geodetic point and astronomical post.

The system of triangulation adopted in passing northward from the Mackinac base-line to a connection with the lake survey triangulation in the eastern end of Lake Superior is as follows:

Quadrilateral.	Vertices.
I	A (west base), B (east base), C (Mackinac Island), D (St. Ignace).
II	C (Mackinac Island), D (St. Ignace), E (Rabbits Back), I (Point St. Martin).
III	C (Mackinac Island), E (Rabbits Back), H (Boiling Spring Point), I (Point St. Martin).

The triangle C (Mackinac Island), D (St. Ignace), E (Rabbits Back) alone could be used, as indeed was done in the former survey, in place of quadrilateral II. Side C (Mackinac Island), I (Point St. Martin) could be computed from triangles in quadrilateral II and quadrilateral III omitted, or omitting quadrilateral III and substituting for I (Point St. Martin) the common vertex of quadrilateral II, III, and IV, —a station on the southeast side of Little St. Martin Island, the line from this new station to C (Mackinac Island) would be computed through better formed triangles in new quadrilateral II, but less favorable triangles would result in new quadrilateral IV. An auxiliary 4-foot station might be placed on the southwest side of Little St. Martin Island to form a quadrilateral with D (St. Ignace), E (Rabbits Back), and C (Mackinac Island), from which a double computation of the line E (Rabbits Back)—C (Mackinac Island), through good triangles, would result, in which case quadrilateral III would be retained. None of these possible alterations commend themselves to me as possessing sufficient advantages either in point of economy or greater accuracy to warrant a change from the system given.

Quadrilateral.	Vertices.
IV	I (Point St. Martin), L (Point Fuyard), Bois Blanc Island, C (Mackinac Island).
V	C (Mackinac Island), Bois Blanc Island, Lime Kiln, Daggett.
VI	Daggett, Lime Kiln, Salter Hill, Duke.

The above six quadrilaterals may be regarded as serving the purpose of connecting the Mackinac base-line with the primary triangulation immediately involved in the resurvey of the St. Marys River, as well as completing, as they do, the triangulation system around Lake Superior.

Quadrilateral.	Vertices.
VII	Duke, Salter Hill, Phillips, Larke.
VIII	Salter Hill, Phillips, Kings Mountain, Iroquois.
IX	Iroquois, Kings Mountain, Mamainse, Whitefish.

In planning the triangulation from the line Mamainse–Kings Mountain to the northern connection a simple triangular system only has been contemplated. However, by reading the line Black Beaver Hill–Michipicoten the angles of the quad-

rilateral Michipicoten, Mamainse, Black Beaver Hill, Pantagreul will be completely read, and by reading the line East Sturgeon Mountain–Iroquois the angles of the quadrilateral Mamainse, Iroquois, Kings Mountain–East Sturgeon Mountain will be completely read. Possibly Whitefish can be seen from East Sturgeon Mountain. The triangle Mamainse, Black Beaver Hill–East Sturgeon remains. It is probable that the line East Sturgeon Mountain–Pantagruel can be read, though this was not determined, in which case the whole system would be made quadrilateral. These additional lines to be read are long and the resulting quadrilaterals not of good form. It is doubtful if any material advantage would be gained in trying to make the system quadrilateral.

Triangles.	Vertices.
X	Mamainse, Kings Mountain, East Sturgeon Mountain.
XI	Mamainse, East Sturgeon Mountain, Black Beaver Hill.
XII	Mamainse, Black Beaver Hill, Pantagruel.
XIII	Mamainse, Pantagruel, Michipicoten.
(XIV)	(Provisionally Mamainse, Michipicoten, Gargantua.)

The following quadrilateral and triangles form a branch system from the main chain to cover the lower portion of the St. Marys River:

Form.	Vertices.
Quadrilateral	Salter Hill, Raber, Lime Kiln, Duke.
Triangle	Salter Hill, Raber, Gaffney.
Do	Salter Hill, Gaffney, Drummond.
Do	Salter Hill, Drummond, Phillips.

From the line Gaffney-Raber a reduction to the secondary system of triangles yet to be planned in the lower portion of the river and among the islands in Potogannissing Bay can be easily effected.

Secondary system in Whitefish and adjacent bays.

Form.	Vertices.
Quadrilateral	Whitefish, Parisian Island, Kings Mountain, Mamainse.
Do	Whitefish, Parisian Island, Maple Island (12), South North Sandy (14).
Do	South North Sandy (14), Maple Island (12), Rudder Head (9), Crawford (1).
Do	South North Sandy (14), Rudder Head (9), West Batchewana (11), Crawford (1).
Triangle	Crawford (1), West Batchewana (11), Sand Point (3).
Hexagon	West Batchewana (11), Sand Point (3), Harmonie River (4), Perry (5), Island (6), South Shore (8), East Batchewana (center of hexagon) (10).
Triangle	West Batchewana (11), Rudder Head (9), South Shore (8).

By using the triangle South North Sandy (14), Maple Island (12), Crawford (1) for the third quadrilateral above, the cutting on the line Maple Island (12)–Rudder Head (9), which is considerable, is avoided. An 8-foot station would then be sufficient for Rudder Head (9).

Form.	Vertices.
Triangle	North North Sandy (15), Rudder Head (9), Crawford (1).
Do	North North Sandy (15), Rudder Head (9), South Pancake (17).
Do	North North Sandy (15), South Pancake (17), North Pancake (18).

Detached triangles.

Form.	Vertices.
Triangle	Rudder Head (9), Crawford (1), Small Island (16).
Do	Crawford (1), Sand Point (3), Carp River (2).
Do	East Batchewana (10), Rock Hill (7), Island (6).
Do	Maple Island (12), South Sandy (13), Rudder Head (9).
Do	Parisian Island, South North Sandy (14), Kars (19).

By substituting triangle Rock Hill (7), Island (6), Perry (5), for the third triangle in the above list, the cutting on the line East Batchewana (10)- Rock Hill (7) is avoided.

In case the line Maple Island (12), Rudder Head (9) is omitted, as previously suggested to avoid cutting, the fourth triangle above would be replaced by the triangle South Sandy (13), Rudder Head (9), Crawford (1).

Form.	Vertices.
Quadrilateral	Whitefish, West Shore (33), Iroquois, Parisian Island.
Do	West Shore (33), Iroquois, North Gros Cap (26), Parisian Island.
Do	Parisian Island, North Gros Cap (26), Maple Point (25), Goulais Point (20).
Triangle	Goulais Point (20), Maple Point (25), Buchanan (21).
Do	Buchanan (21), Maple Point (25), Goulais River (24).
Do	Maple Point (25), Goulais River (24), Mission (22).
Do	Mission (22), Goulais River (24), North Bay (23).

Stations Maple Point (25) and Goulais River (24) are old stations recovered.

Form.	Vertices.
Quadrilateral	West Shore (33), Iroquois, South Gros Cap (27), Parisian Island.
Triangle	Whitefish, West Shore (33), Parsian Island.
Quadrilateral	West Shore (33), Menekaunee (29), Salt Point (28), Parisian Island.
Do	West Shore (33), Taquamenon Island (32), Salt Point (28), Parisian Island.
Triangle	Taquamenon Island (32), Menekaunee (29), Salt Point (28).
Do	Taquamenon Island (32), Ransom (30), Menekaunee (29).
Do	Emerson (13), Ransom (30), Menekaunee (29).

The following five points are designed to be located by intersection:

1. A point on the north end of Parisian Island (old station).
2. A point on the southwest end of Parisian Island (approx. old station).
3. A point on the east end of Iroquois Island.
4. A point on the mainland south of Iroquois Island.
5. A point near the mouth of Taquamenon River.

I wish to call attention to the fact that, owing to the commanding views to be had from Mamainse, Kings Mountain and East Sturgeon Mountain, a few of the secondary stations can be well determined directly from them, and would suggest that advantage be taken of this in each instance where it can be done without the use of a heliotrope. Crawford (1), South North Sandy (14), and North Gros Cap (26) are examples of points visible from two or more primary points.

SITE FOR A BASE-LINE.

Batchewana Island furnishes a site for a 4-mile base-line over remarkably level ground. This base-line would be about parallel to the east and west township line on the island, and would be a little to the north of the latter. At the time this site was examined, July 23-24, it was quite dry. (See my monthly report for July.)

The triangulation in Batchewana Bay has been planned with reference to this base. This system, while requiring but little cutting on the main land, calls for a considerable on the island, which is everywhere, though not heavily, wooded.

This base being situated near the northern end of the work, about 10 miles from Mamainse station, would be a base of verification for the entire work. However, with a 4-mile base-line to begin with at the southern end of the work on the Straits of Mackinac, and a 2-mile one midway, you may decide to omit this one.

If a base-line is not measured on the island, a change in the triangulation system given for Batchewana Bay to the one outlined on map accompanying this report is recommended, as it greatly reduces the amount of cutting required. Points on the island and other points on the main shore can easily be located by adding tertiary triangles. This system could also be used, even were a base measured, by connecting the points marked 6 and 8 on the map with the east and west ends of the base.

REDUCTION TO "SOO BASE."

The reduction from the main chain of quadrilaterals to the "Soo Base" line can be effected in a variety of ways, as will be seen from the map* showing details of

*Not forwarded.

reduction to the "Soo Base" accompanying this report, and hence no particular line of reduction is here indicated.

In this connection it may be stated that station Korah, while serving a useful purpose in the above reduction, taken in connection with stations "Soo" and St. Marie, also serves to locate the astronomical observatory of the survey at Sault Ste. Marie.

Station Azimuth is about 5 miles distant from the observatory and so nearly due north of it as to be seen through the opening in the observatory building for the meridian circle. Azimuth can therefore be directly determined at the observatory.

The following stations were located by Mr. O. B. Wheeler, assistant engineer, the previous year: East base, west base, "Soo," St. Marie, Mirron, Larke, Rankin Mountain.

BUILDING OF STATIONS.

At Michipicoten a new scaffolding was built around the old 9-foot tripod which was strengthened by new braces. A road was also cut out from the mining plant on the northwest shore to the station for the observing party in conveying the instruments to the station, distant about 2 miles from the shore.

At Gargantua a new 4-foot tripod was built and a road cut out from the shore to the station.

At Drummond an 11-foot tripod and scaffolding were built. The geodetic point was also marked and three witness stones set. By preparing these stations for the observer the expense of sending the construction party to these places, which would have been comparatively large, has been avoided. Three 4-foot tripods for secondary stations have also been built.

STATION HEIGHTS.

The mountainous character of the country north of Sault Ste. Marie, especially on the Canadian side, has reduced the required elevation of stations in this section of country to moderate heights and in some instances to a minimum. But south of Sault Ste. Marie, where the ground is comparatively level and mostly covered with tall timber, the necessary heights of stations to avoid cutting have, in a number of instances, been considerable, as will be seen from the following list:

Name of station.	Height of station.	Name of station.	Height of station.
A (west base)	12 feet.	*Secondary stations*—Cont'd.	
B (east base)	Do.	Carp River (2)	4-foot tripod.
C (Mackinac Island)	This station, renewed in 1886, is in good condition.	Sand Point (3)	Do.
		Harmonie River (4)	Do.
		Perry (5)	Do.
D (St. Ignace)	8 feet.	Island (6)	Do.
E (Rabbits Back)	4-foot tripod.	Rock Hill (7)	Do.
H (Boiling Spring Point)	16 feet.	South Shore (8)	12-foot tripod.
I (Point St. Martin)	Do.	Rudder Head (9)	Height best determined after lines are cut.
L (Point Fuyard)	Do.		
Bois Blanc Island	96 feet.		
Daggett	Do.	East Batchewana (10)	Do.
Lime Kiln	Do.	West Batchewana (11)	Do.
Duke	Do.	Maple Island (12)	32 feet.
Salter Hill	64 feet.	South Sandy (13)	4-foot tripod.
Raber	80 feet.	South North Sandy (14)	12-foot tripod.
Gaffney	16 feet.	North North Sandy (15)	4-foot tripod.
Drummond	11-foot tripod.	Small Island (16)	5-foot tripod
Phillips	32 feet.	South Pancake (17)	4-foot tripod.
Larke	64 feet.	North Pancake (18)	Do.
Iroquois	32 feet.	Kars (19)	Do.
Korah	4-foot tripod.	Goulais Point (20)	Do.
Azimuth	32 feet.	Buchanan (21)	Do.
Rankin Mountain	4-foot tripod.	Mission (22)	Do.
Kings Mountain	8-foot tripod.	North Bay (23)	Do.
White Fish	32 feet.	Goulais River (24)	Do.
Mamainse	25 feet.	Maple Point (25)	Do.
East Sturgeon Mountain	4-foot tripod.	North Gros Cap (26)	Do.
Black Beaver Hill	8-foot tripod.	South Gros Cap (27)	Do.
Pantagruel	48 feet.	Salt Point (28)	20-foot tripod.
Michipicoten	9-foot tripod.	Menekaunee (29)	8-foot tripod.
(Gargantua)	4-foot tripod.	Ransom (30)	4-foot tripod.
		Emerson (31)	Do.
Secondary stations.		Taquamenon Island (32)	Do.
		West Shore (33)	Do.
Crawford (1)	4-foot tripod.	Parisian Island	32 feet.

When the word "tripod" does not follow the height given it is to be understood to mean the height to platform of scaffolding.

SUMMARY OF WORK DONE.

	Number.
Old stations recovered	10
Primary stations located	20
Primary stations built	3
Secondary stations located	34
Secondary stations built	3
Points to be located by intersection selected	5

Site for a 4-mile base-line on Batchewana Island examined.

EXPENSE OF WORK DONE.

The total expense of the reconnoissance, including the cost of stations built by me, is as given below:

Salaries	$2,318.40
Subsistence	149.73
Rent of boats	163.00
Traveling and personal expenses	377.49
Outfit and material	61.00
	3,069.62
Outfit returned	33.00
Total	3,036.62

Very respectfully, your obedient servant,

FRED MORLEY,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. A.

C.—REPORT OF MR. E. E. HASKELL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., June 30, 1894.

SIR: I have the honor to make the following report, in compliance with your verbal instructions requesting me to make an investigation of the possibility of extending the primary triangulation of the resurvey of St. Marys River, to a direct connection across the east end of Lake Superior with the line Gargantua–Mamainse of the old lake survey work; of the possibility of locating Caribou Island from two or more of the stations in the vicinity, and also the possibility of shortening up some of the lines of the system of the river triangulation as planned last season with a view to doing away with many of the long lines over which heliotropes would be required for targets.

For the purpose of making a thorough investigation of these matters I have spent a part of the months of May and June in the field in reconnoissance work, and submit herewith, as the result of my investigation, a sketch* showing the system recommended.

In regard to the possibility of a direct connection across the east end of the lake, it depended upon finding a hill a few miles to the westward of Whitefish Point that would be high enough, with the extra refraction so common in this region, to permit of seeing from it to △ Gargantua (60 miles), on the north shore, which is 431 feet above the lake level. A hill was found in sec. 13, T. 50 N., R. 8 W.,—just back of Crisps Point.—that, by the barometers (mercurial and aneroid) from four independent determinations, was found to be between 260 and 270 feet above the lake.

In the lake survey report for 1873 is given the coefficients of refraction for the lines Vulcan-Saint Ignace, Vulcan-Tip Top, and Vulcan-Michipicoten of the old lake superior triangulation, when they were observed, which are: 0.275, 0.315, and 0.343 respectively. A coefficient of refraction of 0.20 and the height of △ Gargantua, 431 feet, would see 32.8 miles, and a 100-foot station on the hill selected at Crisps Point, making total height above the lake 360 feet, would see with the same refraction 30 miles, and the sum of these two distances is 62.8 miles, showing the line to be possible under less favorable conditions than existed when the observations above referred to were made.

*Submitted with report of Lieut. Charles S. Riché.

For further proof of the possibility of this line I made inquiry of several people living in the vicinity of Crisps Point if they had ever seen Caribou Island Light, and found that during the early spring it had been seen repeatedly from the shore at points not over 30 feet above the lake. I also made inquiry of Capt. L. D. Coates, of the steamer *City of Green Bay*, plying between Sault Ste. Marie, Grand Marais, and Caribou and Michipicoten islands, and he informed me that just a short time before (about May 1) he saw Caribou Island Light about 10 p. m. from the deck of his vessel while in Grand Marais Harbor. He was just leaving Grand Marais for Caribou Island and saw the light, it remaining visible for the whole trip across, the distance being 46 miles.

In regard to determining the position of Caribou Island, the distance of Caribou Island Light from △ Gargantua, is 42 miles, from △ Mamainse 60 miles, and from the proposed station at Crisps Point 50 miles. The height of the light itself is 70 feet above the lake, and with a coefficient of refraction of 0.20 would be visible 13.2 miles, showing clearly from data given above that the line Caribou Island Light-Gargantua is possible.

△ Mamainse is 1,250 feet above the lake, and under ordinary refraction would see 47 miles, which distance, added to 13.2 miles, the distance that Caribou Island Light could be seen (with coefficient of refraction = 0.20) would make 60.2 miles, leaving no question whatever about the intervisibility of these points.

With the height of 360 feet above the lake for the proposed station at Crisps Point and a coefficient of refraction of 0.30 this station would be visible 36.8 miles, and with the same refraction Caribou Island Light would be visible 16.2 miles, showing that the line Crisps Point–Caribou is possible. Hence the location of Caribou Island is reasonably certain by a single triangle, and within the possibilities by a quadrilateral, without building a station over 70 feet in height, and it may be that the light itself will answer every purpose of a station.

In regard to shortening up some of the lines of the system of the river triangulation, I have located four new stations; namely, Fisher, Havilland, Pennefather, and Laird (see sketch), enabling us to abandon two that were a long distance inland on the Canadian side, and thereby change the system in such a manner as to materially shorten several lines, bringing them down to a length over which targets can be used.

This change also facilitates connecting the primary system with the tertiary triangulation of the river below Sault Ste. Marie, as will be seen by glancing at the sketch. Connection is made with one station on Hay Lake, two on Lake George, one at the foot of Middle Neebish, and probably one at Ross', one on Winter Point, and one on Rocky Point when the river work is extended that far, thus completely tying together the two systems from the "Soo" base to a point in the middle of Mud Lake.

The connection with the proposed base on Batchewana Island is also very much simplified, requiring but two stations to get from the main system to the base stations.

In regard to this proposed base it would seem advisable to make it the full length of the island from east to west, placing the stations as close to the shore as is consistent with safety, in order to have as little cutting as possible in clearing lines of sight.

With the exception of the station Crisp, at Crisps Point, there are none to build that are over 50 feet in height, and the majority of them much less than this, while at a few only a tripod on which to mount the instrument—about 4 feet in height—will be required.

Very respectfully, your obedient servant,

E. E. HASKELL,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. A.

D.—REPORT OF MR. GLEN E. BALCH, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., June 30, 1894.

SIR: I have the honor to submit the following report concerning the building of stations, clearing lines of sight, etc. for triangulation, resurvey of St. Marys River, during the year 1893, which work was assigned to me in your letter of instructions dated April 26, 1893.

In accordance with your letter of March 26, 1893, informing me of my appointment by Col. O. M. Poe, and requesting me to report for duty as soon after April 1 as possible, I reported to you at Sault Ste. Marie on April 26, and began work at once, being busy during the rest of the month making preparations for the work.

I made a requisition for and obtained an outfit suitable for building stations 50

feet in height or less, as it was thought at that time that none would be needed higher than that. A party, consisting of 1 teamster and team, 2 carpenters, 4 laborers, and a cook, was organized.

During the first half of May the carpenters were employed in making camp chests, tables, etc. With the rest of the men lines of sight were cleared between stations Ste. Marie and Rankin Mountain; station Mirron and stations Rankin Mountain, Ste. Marie, East Base, and Larke. Station Mirron was also repaired and reference stones set.

On the 14th of May the party went into camp at Iroquois, where an observing station with 40-foot tripod set 4 feet in the ground was erected on a wooded hill about a mile from the point where the old lake survey station was located.

Although this station was considerably higher than the instructions (given me by Mr. Morley, who was doing the planning) called for, yet it was found necessary to clear away all the timber on the summit of the hill north, east, and south of the station.

A station was begun at Larke, but owing to delays for timber and on account of rainy weather it was not completed until well into June.

Finding that it was going to be necessary for me to be away from the party at times in order to make preparations for the next station, I asked for and obtained permission to engage a man who could take charge of the work during my absence. Mr. R. L. Ames was selected to fill this place, with a title of recorder. He reported for duty on June 7, and began work immediately.

Stations were also built at East Base, Azimuth, Korah, and South Gros Cap during June. The station Korah was formerly called "Bare Rock."

At station Azimuth we were delayed a few days by the Canadians, who owned some adjacent land, not allowing us to cut timber either for a station or in clearing lines of sight.

During July stations were erected at Duke, West Base, Rankin Mountain; and at Kings Mountain an 8-foot tripod was put up, so that, if it was decided that it was needed, a target could be placed thereon.

At station Duke my instructions called for a station with platform 80 feet above ground, and, in accordance with them, I ordered timber for a station of that height. Upon making an examination from a tree top at the place selected for the station I found that it would require a station with platform 100 feet high, or else it would be necessary to cut 7 or 8 lines of sight varying in length from 1 to 5 miles. Accordingly I ordered additional timber and erected a station of that height, which action you approved upon my reporting it on my return to the city.

In building these large stations we worked at a great disadvantage on account of not having an outfit strong enough for such work. Broken tackle at station Duke caused us two days' delay.

At West Base a 20-foot station was erected to enable the observer to see East Base over the top of the street cars, as the line between these stations follows the street-car track for the greater part of the distance. After being occupied, this station was removed to Salt Point, in Whitefish Bay.

During August stations were built at Phillips and Salters Hill, considerable cutting being done at both, as at neither did the height called for in my instructions raise the observer above the surrounding trees. The roads to both of these stations were very rough and hilly, the one to Phillips especially so.

The stations above Sault Ste. Marie being badly needed at this time, I returned there with my party and made preparations for building the stations around Whitefish Bay. As these stations were for the most part small, and were scattered all along the shore and islands of Whitefish Bay, it was deemed advisable to engage a tug that could accommodate the entire party, and also carry prepared timber for most of the stations.

Timber was purchased here in the city and the party put to work framing stations and getting them ready to carry ashore and put up, so as not to keep a tug employed any longer than necessary. During this time I visited all the available tugs in the vicinity and obtained a number of offers, of which that of the tug *Mystic*, B. B. Moiles, master, was the most reasonable of all the tugs suitable for the work. She was engaged, with her crew, at $23 per day, the Government furnishing her coal.

On September 6 the tug began work and taking on board supplies and timber for 12 stations we went to Whitefish Point, where we put up a station, with tripod 40 feet high and set 6 feet in the ground, and also replaced the old astronomical post near the shore, which was badly decayed.

The fact that the station at Whitefish Point, including cost of timber and tug, while it was en route for the point and while building the station, was the cheapest one built outside of Sault Ste. Marie, is a good argument in favor of framing the stations in the city and carrying them to their site when it is in an accessible locality. The cost of finding and cutting timber and removing the bark has in almost every case exceeded the cost of sawed timber necessary for a station.

The stormy weather that continued most of the month of September delayed us considerably, especially in landing on the rocky shores. The plan of work that we followed was to land a party of 7 or 8 with camp outfit at a point where one of the larger stations was to be built, and, with the rest of the party and tug, put up the smaller stations till the larger station was completed, then return and move the party and camp to the next point.

The work was carried on in this manner till 14 stations had been finished and another one begun, when the work was interrupted by the burning of the *Mystic* on September 27, with all the property, both Government and private, that was on board at the time. Eight of the party were in camp on Maple Island at the time of the fire with a large part of the outfit. The rest of the party were on shore with me, about 2 miles from the tug.

The loss of the tug caused us to return to Sault Ste. Marie, and the Government tug *Myra* was sent to Maple Island to bring back the rest of the party as soon as they had finished that station.

During the time that we had the *Mystic*, Capt. Moiles assisted us in every way in his power, sending as many of the tug's crew as he could spare to assist us in landing, and also at times to assist in clearing lines.

On October 3 Mr. R. L. Ames, my recorder, left to resume his college work at Ann Arbor, having given the best of satisfaction in all his work.

On October 2 I started with the party to build a station on the site of the old Lake Survey station Mamainse. We took passage on the steamer *Telegram*, which landed us on the north shore of Batchewana Bay, about 9 miles from the station and near the old mining dock. As no horses could be obtained in that locality, we pitched our camp on the shore and had all our provisions carried out to us while we were building the station and cutting a trail back to the shore. Two Indians, Tommy Robinson and Jim Narsaub, were engaged as guides and to carry provisions for us.

We were delayed a few days after the work was finished through not being able to get transportation to Sault Ste. Marie as soon as we wished.

It was decided upon our return that no more stations would be built during the season as the appropriation was running low, so our outfit was cleaned, repaired, and stored away in the Government warehouse, and party disbanded.

In company with Mr. Thomas Russell I made a week's trip among some hills about 30 miles south of Sault Ste. Marie to determine their height by barometrical readings for Mr. Morley's use in planning triangulation.

I closed the field for the season with the building of an 18-foot station at South Gros Cap in place of the 4-foot one already there, so as to be able to read the line South Gros Cap–Larke in both directions.

From the close of the field work to the close of the fiscal year 1894 I have been engaged in general office work, varied by occasional short trips to points connected with the triangulation, except for the months of March and April, during which I was on duty connected with the improvement of the 20 and 21 foot channel, such as sounding through the ice, plotting notes, computing, etc.

The cost of building stations, clearing lines, etc., during the year has been as follows:

Salaries	$3,427.71
Outfit and tools	279.12
Subsistence	907.91
Building materials	656.03
Transportation and contingences	753.46
Total	6,024.23

The Government tug *Myra* has been utilized a number of times in transporting the party and supplies to stations along the river, thereby saving us from considerable expense and delay.

The following table shows the approximate cost of the stations, cost per vertical foot of height, and also of clearing lines and roads. In the column for height the entire vertical height of the tripod is given. In determining the cost of the stations, the cost of the outfit, hardware, etc., was divided among the stations in proportion to their height.

Stations.	Vertical height.	Cost of station.	Cost per foot.	Cutting, etc.	Total.
	Feet.				
Iroquois	40	$172.12	$4.30	$64.04	$236.16
Larke	70	533.96	7.63	6.37	540.33
East Base	33	118.96	3.60	52.72	171.68
Azimuth	40	229.25	5.73	169.23	398.48
Korah	4	20.94	5.23	10.42	31.36
South Gros Cap	4	14.94	3.73	26.23	41.17
Do	18	35.42	1.97	10.50	45.92
Duke	108	908.71	8.41	12.67	921.38
West Base	20	70.17	3.50		70.17
Kings Mountain	10	36.18	3.62	15.00	51.18
Rankin Mountain	4	21.26	5.31	176.02	197.28
Phillips	40	226.89	5.67	142.20	369.09
Salters Hill	74	418.44	5.65	170.63	589.07
15 stations in Whitefish Bay	204	1,387.26	6.80	307.09	1,694.35
Mamainse	30	196.80	6.56	208.73	405.53
Repairs to stations built in 1892.					
Ste. Marie	24	28.18		10.50	38.68
Mirron	57	17.03		146.55	163.58
Soo	6	12.77			12.77
Cut stones on hand					46.05
Total					6,024.23

DESCRIPTION OF STATIONS.

Duke.—Is in the northeast quarter of the northwest quarter of Sec. 33, T. 44 N., R. 1 W., Chippewa County, Mich. Height of station 108 feet (sill to top of tripod). The geodetic point consists of a ⅝-inch hole between the letters U. S. cut in top of a stone 6 by 6 by 24 inches, set about 4 feet below surface, with a 6-inch post with a nail center set over it for a surface mark. Two reference stones were set on a line 33 feet north of the section line between sections 33 and 28. These were common field stones with crosses cut in top and letters U. S. on side facing station. Size of stones about 10 by 14 by 30 inches. The cross on the west stone bears N. 46° 30′ W. 203.7 feet from the geodetic point. The cross on the east stone bears N. 55° E. 236.75 feet from the geodetic point. Distance between reference stone, 344 feet. Center of 36-inch pine stump S. 48° W. 59.5 feet. Fifteen-inch pine near the road N. 21° E. 173 feet.

Rankin Mountain.—Is on a projecting point of a range of mountains about 7 miles northeast of Sault Ste. Marie, Ontario, and is north of the wagon road to Garden River, and east of an old mining road up to the mountain. The geodetic point is a 4-inch nail cemented into the rock, with a triangle cut into the rock around it, also the letters U. S. Reference points are two crosses cut into the rock; (1) bearing N. 53° 15′ W. 57.75 feet, (2) bearing S. 25° 30′ W. 60.9 feet. These two crosses are 90.55 feet apart. A 16-inch pine tree bears N. 83° W. 445 feet from the geodetic point.

Kings Mountain.—Is on the highest point of what is called Kings or Slate Mountain, in the northern part of section 5, Vankoughnet township, Ontario. Only a tripod was placed there, as it was not certain that it would be needed. The hill is the most prominent one in sight northeast of Goulais Bay and north of Goulais River.

Phillips.—Is situated on the highest peak of a mountain about 9 miles east of Echo Bay station and about 10 miles north of Stobie station, both on the Canadian Pacific Railroad, and about 1 mile north of a small lake on land owned by Mr. Hugh Phillips. The station is supposed to be in lot 4 of the third concession of Coffin Addition, Ontario. Top of tripod is 36 feet above ground. Geodetic point is a ⅝-inch hole between the letters U. S. in the top of a cut stone 6 by 6 by 24 inches and 3½ feet below surface. A wooden post with nail in center set above stone for surface mark. Reference stones are four field bowlders with crosses and letters U. S. on them. They are set in a square with sides 35.35 feet. The geodetic point is in the exact center of the square and 25 feet from the cross on each stone. Crosses are approximately north, south, east, and west of the geodetic point. A 24-inch maple bears S. 85° 41′ E., and is 64 feet distant.

Salters Hill.—Is on the northwest edge of a hill on St. Joseph Island, known as Salters Hill, about half a mile south of the Hilton road and 3½ miles from the west shore of the island. Top of tripod about 70 feet above the ground. The geodetic point is a ⅝-inch hole between letters U. S. in top of cut stone 6 by 6 by 24 inches, set about 3 feet below surface, with a wooden post with nail center set above it for a surface mark. Reference stones consist of four field stones left in their natural

beds, but with cross and letters U. S. cut on each. Bearings and distances to them are as follows: (1) N. 3° E. 60.72 feet; (2) S. 75° 30′ E. 32.4 feet; (3) S. 7° E. 60.9 feet; (4) S. 84° W. 44.7 feet. Distance between crosses on reference stones (1 to 2) 74.2 feet; (2 to 3) 57.6 feet; (3 to 4) 76.3 feet; (4 to 1) 80.5 feet.

Whitefish.—This station is located on a small sand hill about 560 feet southwest of the center post of the Whitefish Point light tower. The tripod of the station is 40 feet high and set 5 feet in the sand. The geodetic point is a ⅜-inch hole between the letters U. S. and the top of a stone 6 by 6 by 24 inches, set 6 feet below surface with an oil barrel around it. Post with nail in center set over it for a surface mark. Reference stones are two cut stones 2 feet long with tops dressed to 4 inches and letters U. S. cut on the side facing station. These are set in the ground at the foot of the sand hill and with the bearings and distances as follows: (1) N. 12° E. 120 feet; (2) S. 75° W. 120 feet. Center post of steel light tower N. 56° E. 560.8 feet. Astronomical post S. 34° E. 825.5 feet. Center of astronomical post to center post of steel light tower 1,007.36 feet.

Parisian.—Is on the highest point of the ridge that runs along the west side of Parisian Island. Top of tripod is 36 feet above ground. The geodetic point is a ⅜-inch hole between the letters U. S. and the top of a cut stone 6 by 6 by 24 inches and set 2 feet below the surface. Two reference stones (common field stones), with cross and letters U. S. cut on them, are set as follows: (1) Stone bears N. 18° 30′ E. 24 feet; (2) N. 72° W. 50 feet from the geodetic point.

North Gros Cap.—Is on the rock point that projects into Whitefish Bay and forms the southern limit of Goulais Bay. A 4-foot station was put up here, setting on the solid rock. Geodetic point is a ½-inch hole drilled in the rock with a triangle (6-inch sides) cut around it. Reference marks are two crosses cut in the rock with letters U. S. near them. (1) Cut in sloping face of rock, bears nearly east and is 43.22 feet from geodetic point; (2) bears S. 60° E. 70.75 feet from geodetic point, and is cut in the vertical face of rock near a 6-inch oak tree.

Maple Island.—Is on the west shore of the island of the same name, about 40 feet from the water's edge. The station is about 35 feet high. The geodetic point is a well-shaped field stone about 6 by 5 by 24 inches, with a hole drilled in the top between the letters U. S. The stone is set with the top 6 inches below surface. But one reference mark was made; a cross and letters U. S. were cut on a large bowlder N. 6° W. and 104.2 feet from the geodetic point. Corbay Point light bears N. 9° 33′ W. from the station.

Maple Point.—Is on a projecting point on the south shore of Goulais Bay. The station consists of a 6-foot tripod set 2 feet in the ground. The geodetic point is the original Lake Survey mark, a lead center between the letters U. S. on the top of a cut stone 6 by 6 inches by (length unknown), set with top about 1 foot below surface and about 45 feet back from shore. Reference marks are a cross cut on a large bowlder in the water about 15 feet from shore, bearing N. 47° W. 61.9 feet from the geodetic point, and an 8-inch birch tree bearing S. 37° 30′ W. 36.55 feet.

Goulais River.—Is on the sandy shore a few hundred feet north of the middle mouth of the Goulais River and about 60 feet from shore. Station is a wooden post 12 inches by 8 feet, set with top about 42 inches above ground. This is the same point occupied by the old Lake Survey post. A long-necked bottle is set below this post, and is directly under the spot occupied by the center of the old post.

North Bay.—Is about 2 miles north of the Goulais River station and about 30 feet from shore. The station consists of a 10-inch spruce tree cut off about 4 feet above ground and covered with a plank cap. A platform was built around the stump for observer to stand on. The geodetic point is ½-inch iron rod 6 inches long driven into the stump. Reference points are crosses on two bowlders near water's edge. (1) South 36.7 feet; (2) southwest 34.8 feet.

Mission.—Is about 1 mile north of the Indian settlement on Goulais Bay and about 20 feet from the shore. The station is a poplar stump treated as at North Bay. Reference points are crosses on two bowlders (rather small). (1) North 14.36 feet; (2) southwest 39.2 feet.

Buchanan.—Is on the edge of a bluff at the shore on Buchanan Point, about one-half mile west of the Indian settlement in Goulais Bay. The station is a 6-foot tripod set 2 feet in the ground. The geodetic point is a ⅜-inch hole between the letters U. S. in top of a cut stone 6 by 6 by 24 inches set 18 inches under surface. Reference points are a 10-inch pine tree northeast 58.19 feet, and an 8-inch oak tree northwest 40.4 feet.

Goulais Point.—Is near the end of the point of land that separates Goulais Bay from Whitefish Bay, about 30 feet from shore. The station is a 4-foot tripod set 8 inches in the ground. The geodetic point is a ⅜-inch hole between the letters U. S. cut in the top of a stone 6 by 6 by 24 inches, and set 6 inches below the surface with a flat stone above it.

Sand Point.—Is on the long sandy point that projects out from north shore of Batchewana Bay toward the east end of Batchewana Island. The station is a 6-foot tripod

set about $2\frac{1}{2}$ feet in the sand. The geodetic point is a cross cut on the top of a dressed stone 4 by 4 by 24 inches, and set with top 6 inches above surface.

Crawford.—Is on the edge of a bluff near the shore, about one-fourth of a mile west of Crawford's landing, and about $1\frac{1}{2}$ miles northeast of Corbay Point light. The station is a 4-foot tripod. The geodetic point is a cross on a dressed stone 4 by 4 by 24 inches, set 6 inches above surface. Letters U. S. cut on side of stone.

South Parisian.—Is an 8-foot wooden post set $4\frac{1}{2}$ feet in the ground as near as it was possible to locate, where the old Lake Survey station was, on the south end of Parisian Island. The remains of the old station were found, but I could find nothing of the old geodetic point.

Salt Point.—Is on the extremity of a point of land on the south shore of Whitefish Bay, about 9 miles west of Iroquois Island and about 30 feet from shore; 20-foot tripod put up here; rest of station unfinished. The geodetic point is a $\frac{5}{8}$-inch hole between the letters U. S. in the top of a cut stone 6 by 6 by 24 inches, set with top 3 inches above surface of the ground.

Mamainse.—Is the same point that the old lake survey used, and is on the highest peak in the vicinity, about 8 miles north of Batchewana Bay, and 8 miles east of Mamainse Point. The station is set on solid rock and is 28 feet high. The geodetic point is $\frac{1}{2}$-inch hole between the letters U. S., cut in the flat top of a field stone, about 2 feet long, and set down to the solid rock, with top 6 inches below surface. Reference points are: (1) Center of top of old astronomical post southeast 68.44 feet; (2) cross and U. S. on rock just to left of line to astronomical post, 22.68 feet distant; (3) cross and U. S. on rock nearly south 43.84 feet.

South Gros Cap.—Mentioned in my report for the fiscal year ending June 30, 1893, as "Gros Cap." The station has been changed from a 4-foot one to an 18-foot one.

For descriptions of the rest of the stations built during 1893, see my annual report for that year.

A set of silver prints,* from negatives taken during the progress of the work, is submitted with this report.

Very respectfully, your obedient servant,

GLEN E. BALCH,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. Army.

E.—REPORT OF MR. E. E. HASKELL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., June 16, 1894.

SIR: I have the honor to make the following report upon the field work of the angle reading and the reduction of the observations of the primary triangulation of the resurvey of St. Marys River, Michigan.

NARRATIVE.

The field work of the angle reading began July 5 and lasted until November 29, 1893. During this time the party occupied 11 stations, made 20 measures each of 91 primary angles and 8 measures each of 67 secondary angles, in addition to setting and frequently testing all of the targets used.

The interval from July 5 to 11 was employed in preparing and setting targets and in collecting the necessary outfit for the party. July 12, the instrument—Troughton & Simms theodolite No. 3—was taken to west base and mounted and the angle reading proper begun.

Owing to the close proximity of the first four stations of the system to Sault Ste. Marie, the party did not go into camp until August 17, when they moved to △ azimuth. From August 17 to November 20, or the date on which the occupancy of △ South Gros Cap was finished, the party lived in camp. On leaving South Gros Cap for △ Iroquois it was thought best, owing to the lateness of the season and the fact that there was a heavy fall of snow on the ground, to abandon camp and the party live with the light-keeper at Point Iroquois. Accordingly, at the request of Assistant Engineer David Molitor, my camp outfit and cook were turned over to him, he being engaged in topographic work in the vicinity, walking to and fro from his own camp, which was some 4 miles farther to the eastward.

The party finished the angle reading at △ Iroquois on November 28, and on the next day moved everything to the office in Sault Ste. Marie, Mich., thus closing field work for the season.

* Not forwarded.

With the exception of a short interval, when the services of a second observer's attendant was required, owing to heliotrope work and to the necessity of packing our instruments for some distance, the party consisted of the observer, one recorder, one observer's attendant, and, while living in camp, a cook—heliotropers when required.

Mr. J. A. Holwill was recorder from July 8 to September 18; Mr. Jacob Bainbridge, observer's attendant from July 5 to September 18, and recorder from September 19 to November 29; Mr. John M. Hogarth, second observer's attendant from August 30 to September 18, and observer's attendant from September 19 to October 23; Mr. Oliver McNeely, observer's attendant from November 11 to November 29, and Mr. James Doran, cook for all of the season spent in camp. To each I desire to express my thanks for efficient service rendered.

Beginning with the base stations of the "Soo" base the primary stations occupied were: West base, east base, Soo, Ste. Marie, azimuth, Korah, Rankin Mountain, Murray, Larke, South Gros Cap, and Iroquois. For the relative position of these stations and an idea of the primary system of the river, see sketch, p. 4350, of the Report of the Chief of Engineers, U. S. Army, for 1893.

The secondary angles read from the primary stations were to stations of the river triangulation of the improvement work, to light-houses, to church spires, and to all prominent objects of a permanent character located in close proximity to the river.

The weather throughout the season was fairly good. From what I gather from the reports of the U. S. Weather Observer at Sault Ste. Marie, Mich., the conditions did not differ much from those of an average season, and up to the time when lines became so long as to require the use of heliotropes—September 1—very good progress was made. From this time forward, however, the advancement was rather slow, a good reason for which will be found by examining the weather summary for the months of September, October, and November, an extract from which is here given.

During September there were 3 cloudless, 10 partly cloudy, and 17 cloudy days; during October 1 cloudless, 7 partly cloudy, and 23 cloudy days; and during November 1 cloudless, 6 partly cloudy, and 23 cloudy days; showing that during the 3 months there were 5 days when it was certain that a heliotrope could be used, 23 days when there was a possibility that it might be used, and 63 days when it was certain that it could not be used.

METHODS.

In regard to the methods adopted in the field work it may be stated that, while we have followed in a large measure those of previous work of this character, certain changes have been introduced with a view to lessening field work and also reducing the labor of the final computations.

In this direction the number of measures made of each primary angle or the number of positions of the circle on which the angles were read, has been reduced from what is common practice in this class of work, thus lessening the time required for the occupancy of stations.

It was thought that this change could be introduced in safety, in view of the fact that the instrument to be used (Troughton & Simms theodolite No. 3) is one of a high grade, with all of the refinements required for a first-class instrument, and it is believed that the results which will be exhibited later will prove that this change was warranted.

In mounting the instrument at stations and in setting of targets and heliotropes no eccentric positions, with one exception, have been allowed, thus avoiding the necessity of "reductions to center" and leaving the work so that at the end of every day's observations, the observer could tell exactly the value of his results. The exception noted was a target on the observatory which had to be eccentrically mounted to be seen from "Soo," for one over the center fell behind a chimney of a power house from which quantities of smoke were continually being emitted.

The usual precautions of having the instrument firmly mounted on a good support, of protecting it from the direct rays of the sun and from the wind, of seeing that all of its parts worked freely and that it was kept in good adjustment, were carefully attended to.

Measuring primary angles.—The programme followed throughout the work was to read each angle independently. The instrument having been carefully adjusted and leveled, the telescope was set on the left-hand target of any angle and the micrometers read. It was then set on the right-hand target and the micrometers again read, the difference between these readings being called a positive single result. The whole operation was then repeated in reverse order, beginning with the second target, giving a negative single result. The mean of these two results was called a combined result and is free from "station twist."

The instrument was then double reversed; that is, had its telescope turned 180° in altitude and 180° in azimuth, and a second combined result obtained. The mean

of the two combined results was then taken for a single result, which was free from instrumental errors arising from imperfect adjustment for collimation, from inequality in the heights of the wyes and from inequality of the diameters of the pivots.

The position of the circle on which these readings had been made, or the resulting angle, was designated as Position I. The circle was next shifted by means of the trivet through an angle equal to $\frac{360^\circ}{2\,mn}$, where m is the number of equidistant microscopes and n the number of single results sought. In the present work $m=3$ and $n=5$, making the shift for the circle equal 12°. A reading of the angle as outlined above, on this part of the circle, was designated Position II, and gave a second single result.

The mean of the five single results obtained from the five positions of the circle, in addition to the errors eliminated noticed above, was free from periodic errors of graduation, or, more properly speaking, those periodic errors that can be eliminated by the method of observing.

It will thus be seen that each angle was measured twenty times, giving ten pairs of combined results or five single results.

At each station, all the angles around the horizon, between stations, taken two and two completely closing the horizon, were read. When time and weather permitted, the sum angles of triangles forming quadrilaterals were also read, but were not considered as being absolutely necessary, but where read have been used in the adjustment.

The limits set upon the observations were that the sum of the angles closing the horizon should equal 360° within a $\pm 2''$, and that the sum of the three measured angles of a triangle should equal 180° within a $\pm 3''$.

Measuring secondary angles.—In reading angles to locate secondary points, the method followed has been to connect them with one or more of the primary stations by starting in with the first object on the left and reading around to each secondary and the selected primary objects in the order of their azimuth, finally closing on the point of beginning. Then double reverse the instrument and read to all objects in reverse order. The mean of the forward and backward measures of any one angle of the first position of the circle was called a single result of Position I, and was free from "station twist," and from errors of the instrument arising from imperfect adjustment for collimation, from inequality in the heights of the wyes, and from inequality in the diameters of the pivots.

The circle was next shifted by means of the trivet through 15°, n, being made equal to four in the formula laid down under the primary work, and the readings again made in the same order, giving Position II.

The mean of the four single results obtained from the four positions of the circle, in addition to what has already been mentioned as eliminated, was free from periodic errors of graduation, or more properly those that can be eliminated by the method of observing.

So far as was possible each secondary point was read to from at least three primary stations, thereby securing a check on the location of each.

Measuring zenith distances.—At each station the zenith distance to all other stations of the primary system visible was read, four sets being taken to each station. With one exception no more than two sets were ever read to the same point on any one day. The time for them was limited to the interval between 8 a. m. and 4 p. m.

Form of target used.—The form of target used was one that originated on the work of the Mississippi River Commission in 1881 with the party of Assistant Engineer John Eisemann, of which the writer was a member while doing the triangulation of the river between Keokuk, Iowa, and Grafton, Ill. It is a phaseless one, and for this work has been made in sizes of 6, 8, 12, and 24 inches in diameter by 6 feet in length. To describe it briefly: A 6-inch target is made by taking one circular disk of No. 10 and three circular disks of No. 24 sheet iron that are 7 inches in diameter; through the center of the disk of No. 10 punch a ¼-inch hole, for centering target; from this hole as a center strike a circle with 3-inch radius, and then at the 90° points of this circle punch ¼-inch holes; using this disk as a pattern, punch holes in the other disks to correspond, omitting the center hole, which is not needed. Take the No. 10 disk for the bottom plate of the target, and in the holes at the 90° points solder the ends of the rods of ¼-inch round iron that are 6 feet in length, taking care to get them at right angles to the plate. Next slip these rods through the respective holes of one of the other disks, forcing it down to a point 2 feet from the bottom, where it is secured by solder. In like manner secure the two remaining disks at the 4-foot point and the top of the target, respectively, when the frame is complete.

These frames are then divided into three zones by stretching black and white cloth between the diagonals, the bottom and top zones being white with their planes at right angles to each other, and the middle zone black with its plane in either direction.

By this method of construction the target frames are very true and substantial,

but sizes larger than 12 inches in diameter need this modification: The disks made from the No. 24 iron should be replaced by a cross made from No. 10 band iron that is about 1¼ inches wide, for the reason that the large disks cast too large a shadow on the zones of cloth. Three-eighths inch round iron should be used for targets larger than 12 inches in diameter.

The target when set is secured in place at the bottom by a nail through the center hole, and otherwise by guy wires holding it plumb.

By using care they can, as a rule, be so placed as to need no change of position to be visible from all stations from which it is to be seen.

The first heliotropes used were camp-made affairs and answered every purpose, excepting the need of a telescope for picking up the direction of the distant station. About October 1 four Würdemann heliotropes arrived from the engineer depot at Willets Point, and these were used for the remainder of the season. They answered every purpose, but are more complicated than need be, requiring the services of a more or less skilled operator for their manipulation.

Instrument.—The instrument used, as stated before, was Troughton & Simms theodolite No. 3, 14-inch circle. It was purchased in 1876 by the U. S. Lake Survey, and its constants were carefully determined by Mr. R. S. Woodward and will be found in the Report of the U. S. Lake Survey for 1879, Appendix No. 7 of Appendix M M. Mr. Woodward made a careful determination of the value of the graduative space 359°, 55′ to 360°, and this space has been taken as the standard for all observations for run.

On arriving at a new station the first leisure, after the instrument had been mounted, was utilized in making readings for run, measuring the standard space 10 times with the micrometer screw of each microscope.

Previous to taking the field I made a careful determination, by means of a leveltrier, of the value of one division of the striding and vertical circle level tubes, and, as will be seen by a comparison with the values given by Mr. Woodward, the vertical circle tube is undoubtedly the same one that was on the instrument when he examined it. There is some doubt about the other. His value for one division of the striding level for a space of about twelve divisions on either side of a central position and at 60° F. was 0″.898. My determination was for a larger space each side of a central position, namely, about twenty divisions, and was made at a temperature of 63° F. and equals 0″.763.

By Mr. Woodward's determination, the value of one division of the vertical circle level tube for a space of twenty divisions either side of a central position and at a temperature of 64° F. is 1″.026. My determination was for a space of twenty-five divisions either side of a central position, made at a temperature of 73°, and equals 1″.110.

RESULTS.

Of the 11 stations occupied, all fell within the limits in summing the angles closing the horizon on first trial. The largest discrepancy was 1″.82, the smallest 0″.05, and the mean 1″.04. At 5 stations the sum was in excess of 360° and at 6 stations less than 360°.

In the closing of triangles all fell within the limits on first trial. The greatest discrepancy was 2″.98, the smallest 0″.21, and the mean 1″.43. Of the 18 triangles used in the reduced observations 7 closed large and 11 small.

Beginning with the base, the system of triangles, as far as the angles were measured, form a series of quadrilaterals. So in making the reduction of the observations it was thought best to adjust the system by quadrilaterals and thereby save a large amount of the labor that would be required to make a rigid adjustment of the system as a whole. I am of the opinion that a rigid adjustment could add but little, if anything, to the results except, perhaps, ornamental and deceptive precision, for the value of the work must lie in the observations themselves.

In reducing the work a local or station adjustment has first been made and these values of the angles used in making the quadrilateral adjustment.

The results of the computations of the triangulation will be found in Table No. 1, and the geographical positions of the primary stations in Table No. 2. The geographical positions of the secondary points observed from the primary stations will be found in Table No. 3.

All the computations throughout the work have been made independently by Mr. Thomas Russell and myself, and the results compared and made to check, leaving the probability of an error very small indeed.

COST OF THE ANGLE READING.

The total expense of the angle party, including all salaries for the field season, was $2,833.63, of which amount $26.17 is chargeable to expressage on and repairs of instruments, $349.22 cost of camp outfit and the necessary tools, etc., leaving $2,457.94 as the field expenses proper, or a cost of $223.45 per station.

ADDENDUM.

As the primary triangulation ties in the tertiary triangulation of the river between Little Rapids and Point Iroquois, tying directly to it at each end and at several of the intermediate stations, and as many of these tertiary stations were used by the topographers in the course of their season's work, we have, in accordance with your suggestion, procured from Assistant Engineer Joseph Ripley, who executed this work, his computations of the triangle sides—given in Table No. 4—and have computed the geographical positions of the stations, and they will be found in Table No. 5.

The tertiary system must have been executed with great care, for Mr. Ripley's length of the primary line, Iroquois-South Gros Cap, on which it closes, agrees with the primary value within 0.47 of a meter. His azimuth of this line also agrees with the primary azimuth within 16″.

These discrepancies have been distributed throughout the system, making it conform to the primary values, and it is the adjusted values that are given in the table.

Very respectfully, your obedient servant,

E. E. HASKELL,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. Army.

TABLE NO. 1.—*The primary triangulation.*

Stations.	Observed angles.	Corrections.	Adjusted spherical angles.	Plane angles.	Log. sin.	Log. sides.	Sides.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	*Meters.*
Soo	56 23 35.42	+0.46	56 23 35.88	56 23 35.88	9.9205702	3.5052219	3,200.530
West base	95 44 44.49	—0.20	95 44 44.29	95 44 44.28	9.9978127	3.5824644	3,823.529
East base	27 51 39.22	+0.62	27 51 39.84	27 51 39.84	9.6696229	3.2542746	1,795.869
	59.13						
Ste. Marie	49 22 41.17	+0.84	49 22 42.01	49 22 42.00	9.8802562	3.5052219	3,200.530
West base	56 15 45.46	—1.23	56 15 44.23	56 15 44.22	9.9199085	3.5448742	3,506.503
East base	74 21 33.58	+0.21	74 21 33.79	74 21 33.78	9.9836135	3.6085792	4,060.500
	00.21						
Soo	36 53 30.17	+0.24	36 53 30.41	36 53 30.40	9.7783723	3.5448742	3,506.503
Ste. Marie	40 53 15.75	+0.24	40 53 15.99	40 53 15.98	9.8159624	3.5824643	3,823.528
East base	102 13 12.80	+0.83	102 13 13.63	102 13 13.62	9.9900458	3.7565477	5,708.838
	58.72						
Soo	36 53 30.17	—0.01	36 53 30.16	36 53 30.15	9.7783716	3.5448734	3,506.496
Ste. Marie	40 53 15.75	+0.59	40 53 16.34	40 53 16.33	9.8159633	3.5824651	3,823.535
East base	102 13 12.80	+0.73	102 13 13.53	102 13 13.52	9.9900459	3.7565477	5,708.838
	58.72						
Mirron	33 01 26.71	+0.46	33 01 27.17	33 01 27.16	9.7363912	3.5448734	3,506.496
Ste. Marie	64 27 20.28	+1.62	64 27 21.90	64 27 21.89	9.9553293	3.7638115	5,805.124
East base	82 31 10.03	+0.95	82 31 10.98	82 31 10.95	9.9962882	3.8047704	6,379.262
	57.02						
Mirron	34 54 21.81	+0.70	34 54 22.51	34 54 22.48	9.7575746	3.7565477	5,708.838
Soo	39 44 59.29	+0.04	39 44 59.33	39 44 59.31	9.8057974	3.8047705	6,379.263
Ste. Marie	105 20 36.03	+2.22	105 20 38.25	105 20 38.21	9.9842368	3.9832099	9,620.769
	57.13						
Rankin Mt	45 18 58.67	—0.87	45 18 57.80	45 18 57.73	9.8518674	3.9832099	9,620.769
Soo	46 21 49.41	+0.39	46 21 49.80	46 21 49.72	9.8595802	3.9909227	9,793 157
Mirron	88 19 13.15	—0.52	88 19 12.63	88 19 12.55	9.9998134	4.1311559	13,525.579
	01 23						
Korah	39 35 47.10	+0.42	39 35 47.52	39 35 47.42	9.8043964	3.9909227	9,793.157
Rankin Mt	89 36 54.12	—0.73	89 36 53.39	89 36 53.29	9.9999902	4.1865165	15,364.431
Mirron	50 47 20.59	—1.20	50 47 19.39	50 47 19.29	9.8892007	4.0757270	11,904.660
	01.81						
Korah	37 09 05.63	+1.32	37 09 06.95	37 09 06.88	9.7809868	3.9832098	9,620.769
Soo	105 19 00.66	—0.64	105 19 00.02	105 18 59.94	9.9842935	4.1865165	15,364.431
Mirron	37 31 53.18	+0.07	37 31 53.25	37 31 53.18	9.7847575	3.9869805	9,704.664
	59.47						
Korah	37 09 05.63	+1.10	37 09 06.73	37 09 06.66	9.7809862	3.9832099	9,620.769
Soo	105 19 00.66	—0.70	105 18 59.96	105 18 59.88	9.9842936	4.1865173	15,364.459
Mirron	37 31 53.18	+0.36	37 31 53.54	37 31 53.46	9.7847583	3.9869820	9,704.700
	59.47						

TABLE No. 1.—*The primary triangulation*—Continued.

Stations.	Observed angles.	Corrections.	Adjusted spherical angles.	Plane angles.	Log. sin.	Log. sides.	Sides.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	*Meters.*
Azimuth	44 43 03.20	—0.07	44 43 03.13	44 43 03.05	9.8473382	3.9832099	9,620.700
Soo	89 24 01.42	—1.01	89 24 00.41	89 24 00.33	9.9999762	4.1258529	13,672.626
Mirron	45 52 56.68	+0.02	45 52 56.70	45 52 56.62	9.8560715	3.9919482	9,816.300
	01.30						
Korah	84 22 59.95	+1.45	84 23 01.40	84 23 01.37	9.9979102	3.9919482	9,816.300
Azimuth	79 41 58.77	+0.35	79 41 59.12	79 41 59.10	9.9929440	3.9869820	9,704.700
Soo	15 54 59.24	+0.31	15 54 59.55	15 54 59.53	9.4381257	3.4321637	2,704.978
	57.96						
Korah	39 35 47.10	+0.29	39 35 47.39	39 35 47.29	9.8043961	3.9009232	9,793.106
Rankin Mt	89 36 54.12	—0.74	89 36 53.38	89 36 53.28	9.9999902	4.1865173	15,364.450
Mirron	50 47 20.59	—1.06	50 47 19.53	50 47 19.43	9.8893009	4.0757280	11,904.900
	01.81						
Larke	43 11 52.97	—0.19	43 11 52.78	43 11 52.66	9.8353869	4.0757280	11,904.900
Korah	91 45 12.04	+1.78	91 45 13.82	91 45 13.69	9.9997965	4.2401376	17,383.516
Rankin Mt	45 02 53.96	—0.19	45 02 53.77	45 02 53.65	9.8498508	4.0901914	12,308.110
	58.97						
Larke	76 38 14.98	+1.48	76 38 16.46	76 38 16.33	9.9880811	4.1865173	15,364.450
Korah	52 09 24.94	+1.49	52 09 26.43	52 09 26.31	9.8974611	4.0958973	12,470.856
Mirron	51 12 17.21	+0.27	51 12 17.48	51 12 17.36	9.8917552	4.0901914	12,308.110
	57.13						
Observatory	Concluded.	....	142 20 01.91	142 20 01.90	9.7860834	3.9869820	9,704.700
Korah	6 34 34.61	+0.71	6 34 35.32	6 34 35.32	9.0589167	3.2598153	1,818.927
Soo	31 05 22.92	—0.13	31 05 22.79	31 05 22.78	9.7129684	3.9138670	8,201.004
Observatory	Concluded.	....	161 26 48.30	161 26 48.29	9.5026810	3.9919482	9,816.300
Azimuth	3 22 48.92	—0.75	3 22 48.17	3 22 48.17	8.7705482	3.2598154	1,818.927
Soo	15 10 23.68	—0.14	15 10 23.54	15 10 23.54	9.4178665	3.9071337	8,074.835
Soo	15 54 59.24	+0.01	15 54 59.25	15 54 59.23	9.4381235	3.4321615	2,704.984
Korah	84 22 59.95	+1.61	84 23 01.56	84 23 01.54	9.9979102	3.9919482	9,816.300
Azimuth	79 41 58.77	+0.48	79 41 59.25	79 41 59.23	9.9929441	3.9869821	9,704.700
	57.96						
Larke	43 11 52.97	—0.49	43 11 52.48	43 11 52.36	9.8353862	4.0757262	11,904.912
Korah	91 45 12.04	+1.56	91 45 13.60	91 45 13.47	9.9997966	4.2401366	17,383.700
Rankin Mt	45 02 53.96	+0.33	45 02 54.29	45 02 54.17	9.8498514	4.0901914	12,308.110
	58.97						
Iroquois	31 34 39.48	+0.08	31 34 39.56	31 34 39.35	9.7190435	4.0901914	12,308.110
Korah	61 51 13.93	+0.32	61 51 14.25	61 51 14.03	9.9453442	4.3164922	20,724.800
Larke	86 34 06.94	—0.10	86 34 06.84	86 34 06.62	9.9992207	4.3703686	23,482.194
	00.35						
Iroquois	Concluded.	....	22 45 47.03	22 45 46.80	9.5876214	4.2401366	17,383.700
Rankin Mt	27 28 14.24	+0.10	27 28 14.34	27 28 14.11	9.6639770	4.3164922	20,724.800
Larke	129 45 57.70	+1.63	129 45 59.33	129 45 59.09	9.8857335	4.5382487	34,534.145
South Gros Cap.	99 53 45.25	+0.44	99 53 45.69	99 53 45.56	9.9934807	4.3164922	20,724.800
Larke	24 15 25.46	+0.30	24 15 25.76	24 15 25.64	9.6136644	3.9366000	8,643.048
Iroquois	55 50 49.54	—0.61	55 50 48.93	55 50 48.80	9.9177892	4.2407917	17,408.716
	00.25						

TABLE No. 2.—*Geographical positions.—Primary stations.—The Clarke Spheroid of 1866.*

Stations.	Latitude.	Longitude.	Azimuth.	Back azimuth.	To stations.	Distance.	Logarithms.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		*Meters.*	
Observatory (W. Pier).	46 30 06.270	84 20 48.750	178 06 38.87	358 06 29.80	Azimuth....	8,074.836	3.9071337
			16 39 50.57	196 39 32.83	Soo..........	1,818.98	3.2598154
Azimuth	46 34 27.634	84 21 01.251	1 29 17.97	181 29 09.29	Soo..........	9,816.31	3.9919482
			316 46 14.50	136 51 33.13	Mirron	13,672.63	4.1358529
Soo	46 29 09.837	84 21 13.205	211 38 04.57	31 38 36.61	West base...	1,795.87	3.2542746
			268 01 40.45	88 03 50.39	East base....	3,823.58	3.5824644
			165 34 10.04	345 32 47.25	Korah.......	9,704.70	3.9869620
West base ...	46 29 59.353	84 20 29.032	295 53 52.32	115 55 30.23	East base....	3,200.53	3.5052219
			239 38 08.09	59 40 07.33	Ste. Marie...	4,060.50	3.6085792
East base	46 29 14.060	84 18 14.043	190 17 04.02	10 17 25.32	Ste. Marie...	3,506.50	3.5448742
			272 48 14.99	92 51 32.13	Mirron	5,805.12	3.7638115
Ste. Marie ...	46 31 05.794	84 17 44.675	305 50 03.42	125 52 59.30	Mirron	6,379.26	3.8047704
			51 10 41.30	231 08 10.04	Soo..........	5,708.84	3.7565477
Mirron	46 29 04.773	84 13 42.207	90 58 36.79	270 53 09.73	Soo..........	9,620.77	3.9832099
			179 17 49.43	359 17 45.34	Rankin Mt..	9,798.16	3.9909227
Rankin Mt...	46 34 21.906	84 13 47.849	88 54 38.73	268 47 52.82	Korah	11,904.66	4.0757270
			44 36 42.77	224 31 19.57	Soo..........	13,525.58	4.1311559
			71 19 58.78	251 01 26.23	Iroquois	34,534.14	4.5382487
Korah	46 34 14.198	84 23 06.771	0 33 06.77	180 33 02.74	Larke	12,308.11	4.0901914
			308 23 40.34	128 30 30.04	Mirron	15,364.46	4.1865165
			338 58 11.93	158 59 52.48	Observatory.	8,201.00	3.9138670
Larke........	46 27 35.612	84 23 12.327	93 58 55.90	273 47 13.37	Iroquois	20,724.89	4.3164922
			118 14 21.58	298 05 39.54	South Gros Cap.	17,409.72	4.2407917
			257 11 19.13	77 18 12.49	Mirron	12,470.86	4.0958973
			223 44 55.44	43 51 44.58	Rankin Mt..	17,383.52	4.2401376
Iroquois	46 28 21.084	84 39 21.416	217 56 24.44	37 59 25.33	South Gros Cap.	8,643.05	3.9366669
			242 12 33.81	62 24 21.04	Korah	23,462.19	4.3703646
South Gros Cap.	46 32 01.761	84 35 12.051	298 05 39.54	118 14 21.69	Larke	17,409.72	4.2407917

TABLE NO. 3.—*Secondary points located from the primary system.*

Stations.	Latitude.	Longitude.	To stations.	Distance.	Remarks.
	° ′ ″	° ′ ″		*Meters.*	
Court-house flag-staff.	46 29 54.49	84 20 35.02	Soo	1,601.35	Of Chippewa County, Mich.
			West base	197.10	
St. Mary's Catholic church spire.	46 29 55.22	84 20 20.61	West base	220.19	In Sault Ste. Marie, Mich.
			Soo	1,791.99	
			East base	2,983.57	
Canal Park flag-staff.	46 30 07.91	84 20 53.36	Korah	8,118.78	In Canal Park at Sault Ste. Marie, Mich.
			Rankin Mountain.	11,988.65	
			Soo	1,242.38	
Fort Brady flag-staff.	46 29 36.53	84 21 26.38	Korah	8,836.57	The iron flagstaff at New Fort Brady.
			Soo	870.96	
			Ste. Marie	5,471.85	
No. 14 (river triangle).	46 29 44.52	84 17 43.19	East base	1,147.85	A station of the river triangulation.
			West base	3,565.97	
Catholic church spire, Canada.	46 30 27.74	84 19 25.45	Soo	3,326.62	In Sault Ste. Marie, Ontario, Canada.
			West base	1,614.39	
			East base	2,737.59	
International Hotel, Canada.	46 30 48.84	84 20 01.96	Soo	3,413.42	Do.
			West base	3,722.36	
			East base	1,633.36	
Indian Home flag-staff.	46 30 02.79	84 17 07.69	Ste. Marie	2,099.17	On the Shingwauk Home in Canada.
			East base	2,065.58	
Point Aux Pins light-house.	46 27 52.29	84 28 14.66	Korah	13,495.86	
			Larke	6,471.75	
			Iroquois	14,253.56	
Round Island light-house.	46 26 36.13	84 30 48.69	Larke	9,911.40	
			Rankin Mountain.	26,087.17	
			Iroquois	11,411.42	
No. 15 (river triangle).	46 26 49.96	84 29 41.66	South Gros Cap.	11,930.49	A station of the river triangulation.
			Larke	8,427.87	
			Iroquois	12,687.13	
Point Iroquois light-house.	46 29 04.56	84 37 48.56	Larke	18,894.81	
			Korah	21,085.62	
			Iroquois	2,392.84	

TABLE No. 4.—*Tertiary triangulations, St. Marys River, Michigan, Little Rapids to Point Iroquois.*

Station.	Angle.	Side.	Side.
	° ′ ″	*Meters.*	*Miles.*
14	42 24 69.75		
East base Sault Ste. Marie.			
23			
23	59 35 11.0	1,329.70	0.826
21	55 28 46.0	1,270.38	0.789
14	64 56 03.0	1,396.66	0.868
14	58 32 33.2	2,287.41	1.421
21	91 43 47.2	2,680.28	1.665
8	29 43 39.6	1,329.70	0.826
19	80 25 31.1	2,287.41	1.421
8	69 28 22.2	2,172.43	1.350
21	30 06 06.7	1,163.43	0.723
21	45 10 50.6	2,416.23	1.501
8	92 38 06.6	3,402.74	2.114
9	42 11 02.8	2,287.41	1.421
8	42 07 58.3	1,741.77	1.082
6	68 31 55.7	2,416.23	1.501
9	69 20 06.0	2,429.31	1.510
9	48 41 43.5	2,439.01	1.516
6	98 51 41.0	3,208.01	1.993
2	32 26 35.5	1,741.77	1.082
6	41 45 57.5	1,675.61	1.041
2	34 03 35.4	1,408.88	0.875
7	104 10 27.1	2,439.01	1.516
7	87 15 48.5	1,987.78	1.235
2	35 23 09.9	1,152.40	0.716
3	57 21 01.6	1,675.59	1.041
7	34 51 38.5	676.38	0.420
3	42 00 23.0	791.91	0.492
5	103 07 58.5	1,152.40	0.716
2	74 12 07.8	1,987.78	1.235
3	23 30 33.0	824.04	0.512
2	82 17 19.2	2,047.12	1.272
R	54 01 12.1	2,047.12	1.272
2	74 02 45.7	2,432.30	1.511
3	51 56 02.2	1,991.66	1.238
E	39 42 48.4	1,991.66	1.238
R	88 36 22.6	3,116.17	1.936
2	51 40 49.0	2,445.56	1.520
P	78 23 48.6	3,116.17	1.936
E	59 51 39.9	2,751.12	1.709
2	41 44 31.5	2,117.96	1.316
O	53 28 55.6	2,117.96	1.316
P	84 03 33.3	2,621.20	1.629
E	42 27 31.1	1,779.02	1.105
C	58 49 36.9	2,621.20	1.629
O	91 40 29.5	3,062.25	1.903
E	29 29 53.6	1,508.14	0.937
D	85 19 32.2	3,062.25	1.903
C	45 50 51.4	2,204.47	1.370
E	48 49 36.4	2,312.72	1.437

Station.	Angle.	Side.	Side.
	° ′ ″	*Meters.*	*Miles.*
N	90 24 43.1	1,508.14	0.937
O	33 40 47.0	836.55	0.520
C	55 54 29.9	1,249.27	0.776
12	29 02 46.0	836.55	0.520
C	68 18 46.9	1,601.07	0.995
N	82 38 27.1	1,708.83	1.062
17	26 33 17.4	1,601.07	0.995
N	52 02 15.5	2,823.61	1.755
12	101 24 27.1	3,510.62	2.181
15	65 25 52.5	2,823.61	1.755
17	56 42 03.6	2,594.96	1.612
12	57 52 03.9	2,629.13	1.634
10	52 32 09.0	2,594.96	1.612
15	69 26 26.7	3,061.08	1.902
12	58 01 24.3	2,773.23	1.723
L. H., Round Island	69 52 09.1	2,773.23	1.723
15	79 48 34.1	2,907.08	1.806
10	30 19 16.8	1,491.16	0.927
11	55 49 19.3	1,491.16	0.927
L. H., Round Island	83 12 55.4	1,789.83	1.112
15	40 57 45.3	1,181.62	0.734
13	70 23 24.5	1,181.62	0.734
L. H., Round Island	49 20 22.9	951.55	0.591
11	60 16 12.6	1,089.27	0.677
M	42 56 50.0	2,773.23	1.723
10	38 08 00.7	2,513.43	1.561
15	98 55 09.3	4,021.14	2.499
I	37 59 22.4	4,021.14	2.499
M	88 39 20.6	6,531.14	4.058
10	53 21 17.0	5,241.67	3.257
L	97 09 47.4	5,241.67	3.257
M	50 41 54.7	4,088.04	2.540
I	32 08 17.9	2,810.32	1.746
K	79 45 03.9	4,088.04	2.540
I	64 36 12.4	3,752.86	2.332
L	35 38 43.7	2,421.01	1.504
B	52 53 25.3	5,241.67	3.257
I	56 33 59.1	5,485.15	3.416
M	70 32 35.6	6,197.43	3.851
A	63 35 29.7	6,197.43	3.851
I	26 06 16.4	3,044.65	1.892
B	90 18 13.9	6,919.40	4.300
Iroquois	54 57 54.5	6,919.40	4.300
I	78 56 50.6	8,293.89	5.153
A	46 05 14.9	6,087.83	3.783
South Gros Cap	71 15 06.7	8,293.89	5.153
Iroquois	28 02 49.4	4,118.27	2.559
A	80 42 03.9	8,643.52	5.371

TABLE No. 5.—*Geographical positions of the stations of the tertiary triangulation of the river between Little Rapids and Point Iroquois.*

Stations.	Latitude.	Longitude.	Azimuth.	To stations.	Distance.	Logarithms.
	° ′ ″	° ′ ″	° ′ ″		*Meters.*	
△ 23	46 29 03.72	84 17 35.50	112 59 21.71	△ 21	1,396.06	3.145[illegible]
			172 34 32.71	△ 14	1,270.38	3.103[illegible]
△ 14	46 29 44.52	84 17 43.19	110 03 03.35	△ 8	2,680.28	3.428[illegible]
			57 30 30.15	△ 21	1,329.70	3.1237[illegible]
△ 21	46 29 21 39	84 18 35.78	115 39 58.09	△ 19	2,172.43	3.33[illegible]
			145 46 04.79	△ 8	2,287.41	3.359[illegible]
△ 8	46 30 22.63	84 19 36.12	58 23 27.61	△ 9	2,416.23	3.3831[illegible]
			35 11 43.21	△ 19	1,163.43	3.0657[illegible]
			100 31 25.91	△ 6	2,429.31	3.385[illegible]
△ 19	46 29 51 85	84 20 07.50	215 13 20.4	△ 8	1,163.43	3.0657[illegible]
△ 9	46 29 41 60	84 21 12.61	280 33 20.4	△ 21	3,402.74	3.531[illegible]
			169 02 11.6	△ 6	1,741.77	3.240[illegible]
			120 20 28.1	△ 2	3,206.01	3.50[illegible]
△ 6	46 30 30.08	84 21 28.15	87 53 41.3	△ 2	2,439.01	3.387[illegible]
			46 07 43.8	△ 7	1,408.68	3.148[illegible]
△ 7	46 30 05.36	84 22 15.78	121 56 42.1	△ 2	1,675.61	3.224[illegible]
△ 3	46 29 34.67	84 22 40.52	157 19 20.7	△ 2	1,947.78	3.2[illegible]
			214 40 31.3	△ 7	1,152.40	3.061[illegible]
			81 52 54.5	△ R	2,432.30	3.38[illegible]
△ 5	46 29 39 71	84 22 15.06	179 49 15.2	△ 7	791.91	2.8[illegible]
			76 41 16.7	△ 3	676.38	2.83[illegible]
△ 2	46 30 34 06	84 23 22.46	53 36 22.9	∟ 2	824.04	2.915[illegible]
∟ 2	46 30 26.56	84 23 55.60	313 48 06.5	△ 3	2,047.12	3.311[illegible]
			27 50 52 2	△ R	1,991.66	3.29[illegible]
△ R	46 29 23.50	84 24 30.41	119 13 58.0	△ E	2,445.56	3.38[illegible]
△ E	46 30 02.19	84 26 19.40	250 29 57 0	□ 2	3,116.17	3.49[illegible]
			319 21 36.9	△ P	2,117.96	3.32[illegible]
			1 49 08.0	△ O	2,621.20	3.41[illegible]
△ O	46 28 37 34	84 26 23.39	235 18 00.8	△ P	1,779.02	3.250[illegible]
			90 08 35.7	△ C	1,508.14	3.178[illegible]
			56 27 48.6	△ N	1,249.27	3.09[illegible]
△ D	46 29 49 96	84 28 01.33	260 07 24.0	△ E	2,204.47	3.34[illegible]
			345 26 56.2	△ C	2,312.72	3.36[illegible]
△ C	46 28 37 46	84 27 34.10	211 18 07.5	△ E	3,062.25	3.48[illegible]
			326 02 14.3	△ N	836.55	2.92[illegible]
△ N	46 28 14 99	84 27 12.19	63 24 03.1	△ 12	1,601.07	3.20[illegible]
			11 21 47.5	△ 17	3,510.62	3.54[illegible]
△ 12	46 27 51 77	84 28 19.28	214 20 26.4	△ C	1,706.62	3.23[illegible]
			344 47 41.5	△ 17	2,822.61	3.45[illegible]
△ 17	46 26 26.53	84 27 44.50	108 06 03.1	△ 15	2,629.13	3.41[illegible]
△ 15	46 26 49 06	84 29 41.66	173 12 19	△ 10	2,773.22	3.44[illegible]
			222 38 45.7	△ 12	2,594.96	3.414[illegible]
			73 23 44.9	Round Island light-house.	1,491.16	3.17[illegible]
△ 10	46 28 1[illegible] 13	84 30 40.26	280 30 27.5	△ 13	3,061 06	3.48[illegible]
Round Island light-house.	46 25 36 11	84 30 48.09	183 30 47 3	△ 10	2,907.08	3.46[illegible]
			336 35 51 8	△ 11	1,181.02	3.07[illegible]
			267 15 28.9	△ 13	1,069.27	3.03[illegible]
△ 13	46 26 25.69	84 29 50 60	36 52 39 7	△ 11	851.55	2.93[illegible]
△ 11	46 26 01 64	84 30 26.63	212 25 27	△ 15	1,780.82	3.25[illegible]
△ M	46 26 02 41	84 31 17 26	234 16 00.4	△ 15	2,512.43	3.40[illegible]
			191 10 10.4	△ 10	4,021.14	3.60[illegible]
△ I	46 26 30 58	84 35 16.63	244 37 31.7	△ 10	6,531.14	3.81[illegible]
			292 36 56.2	△ M	5,241.67	3.71[illegible]
			120 59 50.2	△ Iroquois	6,087.65	3.78[illegible]
△ L	46 25 06 34	84 33 00.69	231 56 40	△ M	2,810.32	3.44[illegible]
			144 46 52.6	△ I	4,068.04	3.61[illegible]
△ K	46 2[illegible] 25 61	84 35 54.40	109 20 50.3	△ I	2,421.01	3.38[illegible]
			259 06 03.2	△ L	3,752.86	3.57[illegible]
△ B	46 28 56 63	84 31 47 65	353 12 03.4	△ M	5,485.15	3.739[illegible]
			40 05 28.8	△ I	6,107.43	3.78[illegible]
△ A	46 [illegible]	84 [illegible] 26.15	346 22 31 2	△ B	3,044.65	3.48[illegible]
			10 58 01 0	△ I	6,919.40	3.84[illegible]
			60 03 10.0	△ Iroquois	8,283.69	3.91[illegible]
			146 45 10.8	△ South Gros Cap.	4,116.37	3.614[illegible]
△ P	46 29 [illegible] 14	84 25 14.82	217 46 12.4	□ 2	2,751.12	3.4[illegible]

F.—REPORT OF MR. H. VON SCHON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., June 30, 1894.

SIR: I have the honor to submit herewith my annual report for the fiscal year, from July 1, 1893, to June 30, 1894, consisting of two parts, viz:

Part I. Report on the topographical survey along American shore of St. Marys River from July, 1893, to December, 1893.

Part II. Report on mapping, charting, sketching, and office operations from December, 1893, to June 30, 1894.

PART I.

SUBJECT OF SURVEY.

The subject of the survey, as defined in your letter of instructions to me dated June 13 and July 15, 1893, was the southern shore of the St. Marys River, beginning at Little Rapids, including the western side of the new channel, thence westerly to a point beyond Point Iroquois, afterwards determined to be Salt Point.

The survey was to extend from the shore line of the river back to the crest of the first range of hills parallel thereto, and to include all islands on the American shore.

All light-houses, range lights, buildings; all topographical features relating to the conditions of the ground and improvements; all land survey, section and town lines, and contours for every 20 feet elevation were to be located and plotted on a scale of 1 to 5,000, afterwards changed to 1 to 10,000.

CHARACTER OF TERRITORY.

The character of this territory presents all the varieties to be found in this latitude. Almost the entire shore line on this reach is low and sandy or marshy, a rank growth of timber and brush reaching to the water's edge for more than half of the shore distance surveyed. Occasionally for short distances the shore line rises to a sandy bluff not exceeding 20 feet in height, and for the last 3 miles east of Salt Point outcroppings of a mineral formation are visible on shore, becoming very determined for about 1 mile, rising abruptly out of the water to a height of about 15 feet.

The range of hills coming from the south enters this territory about 1 mile south of Little Rapids at an elevation of about 125 feet above the river level, then gradually approaches the west end of Sault Ste. Marie within one-third of a mile of the river shore at an elevation of about 115 feet, then bears south for a distance of about 2½ miles and again approaches and touches the shore line at the Clay Banks at a height of about 85 feet. Thence it bears west to a point south of Point Iroquois, and thence north rapidly rising and culminating in the Iroquois formation at a maximum altitude of about 440 feet above the river level at Little Rapids. From here the hills gradually recede in a southwesterly direction to a considerable distance from shore, gradually decreasing in elevation.

The drainage of this hill range from Little Rapids to the Clay Banks issues in three small creeks, and thence to its northward course to Iroquois is absorbed by the Waiska River, a water course of considerable volume. The Iroquois range proper drains into two small lakes at its foot which lie about 30 feet above the river and are without any visible outflow. The reach from Iroquois to Salt Point is broken by one creek only.

The country between shore and hills is low and mostly thickly covered with all classes of timber and brush, tamarack, maple, and elm predominating. Occasionally large areas of timber are burnt over, and some depressions of considerable extent are swampy and marshy.

No land was found under cultivation after passing Sault Ste. Marie until the Waiska River is reached, where Superior, a settlement of about 100 people, is located, and some farming is done. On a peninsula 1½ miles north of this is the village of Bay Mills, with about 400 inhabitants, and 1 mile farther north on the beach is the Indian settlement "Mission" with about 75 people. From this point west the character of the country changes, the timber is frequently sprinkled with oak, and considerable of the land is under cultivation. With the exception of the sandstone near Salt Point, no mineral formation of any description was discovered.

The means of transportation through this territory westerly are a dirt road (Waiska Bay road) leading from a point about 5 miles south of Sault Ste. Marie due west to Superior, whence it follows the shore to Mission; thence it leads upon the Iroquois plateau, and due west for about 5 miles to Dollar Settlement, where it terminates. The Duluth, South Shore and Atlantic Railroad touches this territory at Superior, and thence pursues a northeasterly course to Sault Ste. Marie. The Minneapolis, St. Paul and Sault Ste. Marie Railroad enters in the eastern part, leading first north and then northeasterly to Sault Ste. Marie.

The whole territory is located in Chippewa County, Mich., comprising Ts. N. 47, 1 E.; N. 47, 1 W.; N. 47, 2 W.; N. 47, 3 W.; N. 47, 4 W., and the northern half of N. 46, 2 W.

The principal meridian of Michigan passes through the western part of Sault Ste. Marie, Mich.

METHODS.

The organization of the topographical party under my charge consisted of 1 recorder, at $70 per month; 4 rodmen, at $50 per month, each; 1 cook, at $50 per month.

The instruments used were the Buff & Berger transit No. 245, from July 12 to August 14, exclusively. On August 8 the Buff & Berger plane table No. 1, and on August 14 the stadia rods for the same were received, and this instrument was then used when and wherever it was practicable to do so; but much of the weather being stormy, and most of the territory being covered with a rank growth of brush, and large areas being swampy, made it often advisable to use the lightest and simplest field outfit to make reasonable progress possible, and in these cases a Fauth transit was used.

The methods employed with the transit were of the usual practice in "traversing;" the plane table was used in much the same manner, as no sheets with coordinated points located had been prepared for the reach under survey. A section of shore line between reference points was first located, and from it traverse lines to the range of hills were run. These latter had to be invariably chopped through the timber or brush, while much of the shore had to be similarly cleared before the instrumental work could be done. A working programme being decided upon by the chief, lines to be cleared were chopped out by the rodmen under the direction of recorder, the chief running shore line or roads at the same time with transit and two rodmen, or employing himself at plotting. When practicable the plane table was used for detailed surveys, requiring then the entire party. The horizontal distances were obtained by stadia readings always, and the elevations by the vertical angle. Azimuth observations on Polaris were made during the progress of the survey.

The records of the survey were kept in field books, as customary in transit work, and when the plane table was used a field sheet was constructed on the table as the work progressed, notations in field book also being made of distances and vertical angle readings.

NARRATIVE.

The topographical party was organized on July 1, 1893, took the field on July 12, in camp at Little Rapids, moving on July 21 to shore near Ashmun Creek; on August 10, to Point Louisa, Canada; on September 18, to Birch Point; on September 29, to Waiska Bay; on October 16, to Mission Hill; on November 16, to Dollar Settlement; and on November 25, returning to Sault Ste. Marie, Michigan, where it was disbanded.

The survey was begun at △ East Base, tying, in its progress, on 5 primary and 12 tertiary triangulation stations, and closing on the secondary station at Salt Point.

The levels were referred to B. M. "A", at Little Rapids, and checked on P. B. M. "4" of the precise level line located on west side of Waiska River.

RESULTS.

The field work of the season covered about 51.4 square miles of territory, resulting in the location of about 48½ miles of shore line, 28¾ miles of hill range, 19 miles of railroads, 63¾ miles of roads, and all the details of conditions of ground and improvements within this territory.

The office records of this work are in 6 field books and in 7 field sheets, all of them on file at the engineer office at Sault Ste. Marie, Mich.

The cost of the survey was for—

Instruments purchased	$905.60
Camp outfit purchased	286.63
Salaries paid to members of party	2,237.21
Subsistence of members of party	479.08
Repairing camp outfit	6.25
Transportation of members of party	48.56
Total cost	3,963.33

The cost per square mile of survey is found by charging the survey with all amounts paid for—

Salaries, subsistence, transportation, and repairs of camp outfit	$2,771.70
10 per cent of the cost of instruments	30.50
50 per cent of the cost of camp outfit	143.32
Total cost of 51.4 square miles of topographical survey	2,945.52

Cost per square mile, $57.30.

RECOMMENDATIONS.

For future topographical surveys in this region I would respectfully recommend the following organization of topographical party:

One assistant engineer in charge.

Two recorders, to be men capable of running the plane table and to be fair draftsmen.

Five rodmen, to be young men of sound physique, who are preparing for the profession or have had previous experience as rodmen.

One head axman, to be capable to take charge of laborers and to understand the use of reconnoitering instruments, and act as head rodman on a transit survey.

Two axmen, and at times such additional number of axmen as the work may require; these men to be woodsmen, preferably of the region the survey is operated in.

This party to be equipped with the following instrumental outfit:

Instruments.—One transit, 1 Y-level, 2 plane tables, and such additional instruments as are found of service in reconnoitering.

The methods to be employed I would recommend to be as follows: Plane table field sheets of the reach to be surveyed during the season should be fully prepared before the party takes the field, with all bench marks, tertiary, secondary, and primary triangulation stations plotted thereon.

The assistant to plan the work for the two plane-table parties and for the advance chopping of necessary traverse lines, and to locate by additional triangulation and leveling such additional reference points and bench marks as it may be found desirable to establish in order to have no such points originated by plane table alone.

The recorders to secure all needed topographical information by plane-table surveys from these fixed and plotted points, always orienting the plane table by intersection or resection upon points plotted on the sheet. Each plane-table party to consist of the recorder in charge, 2 rodmen, and 1 axman, who is to carry the plane table.

The head axman is to take charge of the chopping needed to clear lines for survey on shore, hill range, roads, and traverse, with such additional axmen as could be employed at intervals for short periods; at other times he would be available with the fifth rodman to form a transit or level crew for the assistant in charge. He is also to take charge of the camp property and tools, and of camp policing and moving of camp.

The salary of such a party on the scale recommended for the coming season, together with salary of 4 additional axmen employed for ten days during each month, and the subsistence on the ratio of last season's cost, would amount to a total about 20 per cent less than the total cost of the two topographical parties last season, while in my estimation such an organization would be capable of accomplishing as much and probably more field work than the two parties did together during the past season.

A not inconsiderable saving in time and expense could be secured, in my opinion, by arranging to have the cook and mess outfits of the entire party located on a flat-bottomed scow, which could be easily moved at any time without necessitating the packing and unpacking of all the utensils on the occasion of each move. More frequent moves of camp could be had and thereby walking to and from work reduced and more time utilized in actual field work. With this arrangement it would be perfectly practicable to have the head axman, with assistance of additional axmen, move the entire camp and relocate same while the field parties were doing their customary field work.

PART II.

MAPPING, CHARTING, SKETCHING, ETC.

After completing the platting and inking of the last transit field work and converting field sheet No. 2 (Big Point to Solomons Point) from St. Marys River level data, to New York tide level data, my office work during period from December, 1893, to June 30, 1894, consisted, as outlined in your letter of instructions dated January 16, 1894, of—

First. Special drafting work required by you from time to time. Under this head I constructed—

(1) A general map of primary triangulation scheme of St. Marys River from line Gargantua-Mamainse to the Mackinac base, scale 1:380160;

(2) A similar plan of primary and secondary triangulation of same reach, scale 1:380160;

(3) A sketch of conventional signs for topography and hydrography;

(4) An outline sketch of chart No. 3, St. Marys River survey, with scheme of sounding lines for ice survey, scale 1:40000;

(5) A similar outline sketch of chart No. 2, St. Marys River survey, scale 1:40000;
(6) A general outline sketch of chart No. 1, St. Marys River survey, scale 1:40000;
(7) A general outline sketch of a chart of Whitefish Bay, scale 1:80000.

Second. The duplication of all field work done by the topographical parties, which necessitated the tracing of sheets Nos. 1, 2, 3, and 4 of the Canadian shore survey.

Third. The preparation of an accurate field plat of Sault Ste. Marie, Mich., on a 1:5000 scale, which absorbed about two months of time devoted to the securing of all available reliable data relating to streets, subdivisions, buildings, etc., from public records, previous surveys, existing maps, and from personal reconnoissance.

Fourth. The preparation of a scheme for the polyconic projection of the reach covered by chart No. 3, on a 1:40000 scale, and of its subdivision into suitable uniform sheets showing both shores of river with hydrography on 1:10000 scale.

The general scheme and two of the sheets were completed. The first one, covering the reach from Big Point to Little Rapids and including Sault Ste. Marie, Mich., and Canada, with all the details previously secured, occupied about two months of my time; the second sheet, covering the reach from Old Vessel Point, Canada, to Point aux Pins, was also completed.

Fifth. The preparation of a similar general and subdivision scheme for reach covered by chart No. 2, of which the general plan only was completed.

Very respectfully, your obedient servant,

H. VON SCHON,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. Army.

G.—REPORT OF MR. DAVID MOLITOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., May 14, 1894.

SIR: I have the honor to submit the following final report relating to operations of the survey party under my charge, July 10 to December 1, 1893, while resurveying the Canadian shore of St. Marys River, between the Shingwauk Home and North Gros Cap.

NARRATIVE.

In accordance with the order of Col. O. M. Poe, Corps of Engineers, dated Detroit, July 10, 1893, I reported for duty at Sault Ste. Marie, Mich., on July 12, 1893.

The remainder of the month of July was devoted to the preparation of camp outfit, office work, etc.

From August 1 to 3 I carried a line of levels from B. M. "A" on the north wall of the '81 lock at Sault Ste. Marie, Mich., across the international bridge and east along the Canadian shore to a point opposite Topsail Islands.

On August 4 I was ordered to cut lines of sight for triangulation work, from △ Azimuth to △ Soo, △ Larke, and △ Mirron. This was done by day's labor, and was completed on August 11.

The plane tables with which the topographical work was to be done arrived on August 7, and I proceeded at once to graduate the stadia rods for the two parties. The party in charge of Assistant Engineer H. von Schon being in the field, it was deemed more practicable for me to do this work.

My party was accordingly organized, and went into camp on the Canadian shore, opposite Topsail Islands, on August 14, 1893.

The party consisted of the following members:

John Conrick, recorder, in the service from July 12 to December 9, 1893; Clifton R. Norton, rodman, in the service from August 1 to September 13, 1893; Richard Johnson, rodman, in the service from August 7 to December 1, 1893; Fred E. Leets, rodman, in the service from August 10 to September 30, 1893; W. J. Steere, rodman, in the service from August 10 to December 1, 1893; Peter Biron, cook, in the service from August 10 to October 1, 1893.

Subsequent changes caused the following to be employed:

Peter Biron, rodman, in the service from October 1 to November 24, 1893; C. E. Thompson, rodman, in the service from September 19 to December 1, 1893; Mrs. Peter Biron, cook, in the service from October 1 to November 22, 1893.

The first camp, near Topsail Islands, was occupied until September 1, and an area of about 5 square miles, including the greater portion of the town of Sault Ste. Marie, Ontario, was covered. As may be inferred, this work contained considerable detail, which, together with a newly organized party, made the progress rather slow at first.

The second camp was pitched on Davignons Point, and was occupied until September 29, having moved camp with the tug *Myra*. An area of about 9 square miles was surveyed from this camp, including the western portion of Sault Ste. Marie, Ontario, the Canadian canal grounds, Swedish settlement, and the country about 4 miles west of the town. A line of levels was also carried from a bench mark near the Canadian Lock, previously established, to a bench mark on Dick Moores Point.

The third camp was located between the Big and Little Carp rivers, about one-half mile from shore. Moving from Davignons Point was done by team and wagon. The area covered from here was about 11 square miles.

More work was done from this camp than would ordinarily have been advisable, but for several reasons it was considered best to survey the Point aux Pins region from here, and not to occupy this locality with a camp.

The more important reasons leading to this conclusion may be thus stated: According to orders, the survey was to extend north as far as the bluffs, and this necessitated an inland camp. As there is only one road, which is very bad in places, leading from Point aux Pins to the north, and as the bulk of the work was done at some distance inland, it was thought best to complete the shore line and the lower portion of marshy country while being located at the Carp River camp, and then to move camp by wagon to the second line road, which was done October 23.

On October 9 and 10 I continued the levels from a bench mark on the base line road, previously established, to about one-half mile east of Gros Cap, at the Indian settlement.

The plane table being the only instrument available up to October 12, was used exclusively previous to this time. The weather was becoming very disagreeable, cold and rainy, so that the plane table was entirely abandoned as soon as a transit was placed at my disposal. Since October 12 the plane table was used only three days, during exceptionally good weather, on shore line work.

The camp No. 4, on the second line road, was occupied from October 23 to November 14. During this time the party lived in a vacant house which they had rented, in preference to camping in tents. The plan was a good one, as there was much rain. It kept the men in excellent health.

About 13 square miles were covered from this camp, completing the survey to South Gros Cap.

At this time continual snowstorms made the progress very slow, but the work was nevertheless continued to North Gros Cap, in compliance with the orders received. This necessitated moving camp to South Gros Cap on November 14, and working as the weather permitted.

The larger portion of my camp outfit was moved to Sault Ste. Marie, Mich., via Point aux Pins, in sleighs, and the party took possession of Assistant Engineer Haskell's camp, as Mr. Haskell was no longer in need of his outfit.

The continued snow made the traveling very slow on the Gros Cap ridge, and as the country is thickly wooded there was much cutting to do, so that this work, covering only about 2 square miles, was not completed until November 28.

Messrs. John Conrick and C. E. Thompson walked to Sault Ste. Marie, Mich., to report the completion of the work and that camp should be moved.

The first opportunity for the tug *Myra* to land at Gros Cap occurred on December 1, when the remainder of the party and the outfit were brought back to Sault Ste. Marie. The trip was very stormy, and one of the tents was blown overboard and could not be recovered.

The plotted and inked field sheets, numbered 1 to 5, together with notebooks comprising the records of the survey, were filed in the office at Sault Ste. Marie, Mich.

The party was discharged and I returned to Detroit in obedience to a written order from Col. O. M. Poe, reporting for duty in Detroit on December 3, 1893.

METHODS.

The plane table with stadia was used exclusively from August 14 to October 12, it being the only good instrument provided for this work. From October 12 to completion of the survey, November 29, a transit and stadia was used, with the exception of three days. This transit had been used by Assistant Engineer E. E. Haskell on the triangulation work, and became available just at the time the cold and wet fall weather set in, and the plane table would necessarily have been discarded.

While working with the plane table the various duties were distributed among the members of the party as follows: The chief of party did the field plotting and took the station settings, directed the rodmen, and planned the general course of the work, besides looking up any doubtful matters. The recorder took the instrument pointings for side shots, recording all readings in his notebook, while the chief would plot the readings and number the points as recorded, so that it was possible to identify each plotted point in the notes.

Three rodmen did the regular rodding work and the fourth carried the plane table. Of the three regular rodmen the best man was selected as head rodman, the second best as side rodman, and the less competent as rear rodman. The man showing the least aptness was detailed to carry the instruments.

The field platting was done in pencil and the sheets were executed in ink during rainy weather and evenings. These field sheets formed a complete record of the work, showing all fences, boundaries, shore line, waterways, dwellings, and all other topographical features of the ground, including 20-foot contour lines. The notes, which contained only the data for finding the elevations of the contour points, were worked up at night by the recorder, and the elevations were then written on the field sheet. When sufficient area had been covered in this manner the contours were drawn. This method was found to be the most expedient when taking 20-foot contours on a scale of 1:10000.

It might be mentioned, however, that on very detailed work in mountainous country, where, say, 5-foot contours may be required and the work is platted on a large scale, it would be best to change the above programme and compute the elevations with a slide rule while on the ground and draw the contours before leaving a station. This method is necessarily much slower, and though it was first adopted, it was soon abandoned and the notes were worked up in camp.

A more detailed account of the manner of doing plane-table work may not be out of place, and may be useful in future work on St. Mary's River.

The plane table was used much in the same manner as a transit in doing stadia work. A field sheet was commenced by locating upon it one of the lines of the tertiary triangulation system, for example, the course △ A–△B, having previously decided upon the area of country to be covered by such a sheet, so that the line could be correctly drawn. This was usually done in camp. One of these stations, as △ A, was then occupied, orienting the table on the line A–B, and shots drawn to all visible stations and prominent objects. The other station △ B was then occupied with the instrument oriented back on the line A–B, as before, and shots drawn to the same points as from the △ A. This then located all the objects sighted, by intersection, assuming that the line A–B was correctly measured off on the field sheet. Such preliminary preparation forms a basis for checking all subsequent work on the sheet, and also affords means to locate the position of the instrument when placed at any point in the field.

The filling in of details on a sheet thus prepared was done precisely as it would have been with the transit and stadia, only that each point was platted immediately in the field and all details were drawn before leaving the ground. It was made a practice to run polygonal lines between the points previously determined, thus checking both the original points, as determined by intersection, as also the polygon. In this way it was scarcely possible to introduce any error in the work.

The transit and stadia was used in the same manner as was done on the Mississippi River Commission survey, and the work was platted in camp and inked in the same manner as the plane-table sheets.

RECOMMENDATION REGARDING METHODS TO BE FOLLOWED IN FUTURE WORK.

The comparative utility of the plane table and transit depends entirely upon the character of the topography and the weather.

The plane table can be advantageously used only in open country and during dry weather. Strong wind is a hindrance.

The transit can be used in any country and in any weather in which men can work.

In open country, where there is much detailed topographical work, I should say that a party could cover about the same area, in the same time, with either instrument; but the plane-table work would be platted, while the transit work would not.

In wooded country, or such localities where there would be comparatively few side shots, the transit has decided advantages, it being a much lighter instrument, especially adapted to quick settings, and requiring no such care as is necessary to prevent the field sheet from becoming soiled or injured.

As may be supposed, my party was considerably delayed between August 14 and October 12, the work being confined to weather which would not injure the plane-table sheets. I have estimated a loss of about twelve days between the dates just mentioned, on which transit work could have been done perfectly well; but having no other instrument, this time could not be utilized for field work, and the men were employed in the best possible manner preparing for future work. This time, therefore, was not an actual loss; yet the field work, which represented the real progress, was delayed.

This was the best part of the season, and between October 12 and November 30, there were only fourteen days which would have permitted the use of a plane table, while with the transit only eight days were lost on account of severe rain and snow storms.

It would seem, then, that a party ought certainly to be equipped with a transit, and, if practicable, to be provided with a plane table to be used when opportunities are offered.

I should also recommend, if new transits be purchased for future work, that these possess some of the features of the Buff & Berger plane table, that is, be provided with a telescope which can revolve on its optical axis, making the adjustment for collimation similar to that of a Y-level. The level should also be a detachable striding level as provided for the plane table. This will make the transit suitable even for running accurate levels.

The tangent screw for the horizontal movement of the plane table is a defective mechanism, for it produces a lost motion in the screw and the ball and socket joint. This movement should be carefully avoided in future instruments. The only perfect mechanism of this kind made up to this time is the movement which Messrs. Buff & Berger make for their transits.

It would be advantageous to have one or more of the stadia rods made to read 500 meters, instead of all to 400, as there is often great advantage in being able to read long station distances.

It might also be suggested that the rates of pay of the party be changed more in proportion to the duties imposed, and the following would seem a fair disposition to make:

	Per month.
Recorder	$80
Head rodman	60
Two side rodmen	50
Rear rodman	$30 to 40
Cook	30 to 50

As the progress of the work is greatly dependent upon the efficiency of the head rodman and recorder, these men should be carefully selected and should possess a full knowledge of the work. The best men for this purpose are young engineer students.

A fair knowledge of drawing is almost indispensable to the recorder, especially while doing plane-table work, as he is called upon at times to take the place of the chief, or do independent work when both transit and plane table are being used simultaneously.

If future work is to be done on a larger scale than last summer's, it might be advisable to provide two recorders, both of whom should be capable of doing instrumental work. Such a party ought to be supplied with one rear and one head rodman in addition to the above personnel. Both instruments might then be employed in the field and each used to its best advantage.

STATISTICS.

Amount of work done.—In attempting to state the amount of work done the only data which conveys a reasonable impression is the area covered, yet this is very unsatisfactory, as the amount of work necessary to survey a square mile of country differs very widely. So, for instance, the vicinity of Sault Ste. Marie, Ontario, requires vastly more detailed work than does the open marsh meadow on Point aux Pins.

During the season's work an area of 40 square miles was surveyed, containing a developed length of shore line of 38.7 miles. Of this area 17 square miles were surveyed with the plane table in 35.5 working days, and 23 square miles with the transit and stadia in 29 working days, making a rate of 0.48 square mile per day with the plane table and 0.65 square mile per day with the transit.

The whole time spent in the field was 109 days, of which 35.5 + 29 = 64.5 days were spent in actual field work. The time lost to field work = 109 — 64.5 = 44.5 days, is accounted for as follows:

	Days.
Sundays	16
Moving camp	6
Loss by rain while working with the plane table	14.5
Loss by rain and snow storms while using the transit	8
Total	44.5

Cost of work.—The following are the expenses incurred in equipping my party and surveying the above area on the Canadian shore of St. Marys River, between the Shingwauk Home and North Gros Cap, between the dates July 1 and December 1, 1893:

Instruments	$305.00
Camp outfit	302.38
Provisions	369.29
Labor, including chief of party	1,899.98
Sundry expenses for traveling, etc	85.36
Total	2,962.01

Of the amount thus expended the instruments and camp outfit are still available for future work. Assuming a depreciation in value of the instruments of 10 per cent and of the camp outfit of 50 per cent of the original cost, the following would represent the actual cost of the survey:

Instruments, 10 per cent of $305	$30.50
Camp outfit, 50 per cent of $302.38	151.19
Provisions, labor, and sundry expenses	2,354.63
Total	2,536.32

This gives the average cost per square mile of survey, $\frac{\$2,536.32}{40}=\$63.41$, including all expenses incidental to the work.

Very respectfully, your obedient servant,

DAVID MOLITOR,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. A.

II.—REPORT OF MR. E. E. HASKELL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., April 28, 1894.

SIR: I have the honor to submit the following report upon the reduction of the observations of the line of precise levels run by Messrs. E. J. Thomas and A. O. Wheeler in June, 1892, between B. M. "A" on the canal lock of 1881, at Sault Ste. Marie, and the water gauge at Waiska Bay.

In my last annual report (p. 4359 of the Report of the Chief of Engineers, U. S. A., for 1893) I made the statement that the elevation of the zero of the water gauge at Waiska Bay should be corrected by a minus 0.152 foot, the difference in the elevation of B. M. "F" and B. M. "A." From the final computations of the levels it appears that Mr. Thomas must have had the elevation of B. M. "A" and called it B. M. "F," so that there is no correction to the elevation of the zero of the gauge at Waiska Bay as indicated in my report. B. M. "F" is the only one mentioned in the notes as the starting point for this line of levels, but the elevation of it or of the bench mark used does not appear, which accounts for my being led astray in my first interpretation of them.

In regard to the connection of this line of levels with the gauge at Waiska Bay we are dependent upon the statement made in the field report, which is undoubtedly correct, as to the elevation of its zero. In the notes there is no statement as to how the connection was made.

In connection with the reduction of the observations I have determined the constants of the precise level, Kern No. 2, with which this line was run and these new values have been used in the computations. These values are given below:

Wire interval between extreme wires equals $1^{m}.038$ for a base of $100+f+c$ where $f=0^{m}.366$ and $c=0^{m}.177$. Hence d, the distance, equals $96^{m}.34\ S+0^{m}.54$ where s equals any intercept on the rod.

The value of one division of the level tube of the striding level was determined by means of a level trier, and found equal to $4''.801$.

The inequality of the collars was determined by the striding level with the result eye-end collar 0.53 of a division of the level tube, or $2''.544$ larger than object-end collar.

The observers were very careful indeed to make back and fore sights equal, so that in the whole line of 14 miles of double line run there is only two or three stretches where any corrections appear. From my computations the zero of the Waiska Bay gauge is 1.1497 meters=3.7720 feet below B. M. "A," agreeing closely with the value given in the field report of the work.

There were four P. B. M.'s determined, located at intervals along the line, and the elevation of these, together with the descriptions of them, are given below:

Elevation above mean sea level of B. M. "A" on northwest wide wall of canal lock of 1881 = 605.872 feet = 184.668 meters.

Elevation of P. B. M. No. 1 above same reference = 642.007 feet = 195.682 meters.
Elevation of P. B. M. No. 2 above same reference = 641.312 feet = 195.470 meters.
Elevation of P. B. M. No. 3 above same reference = 670.321 feet = 204.312 meters.
Elevation of P. B. M. No. 4 above same reference = 648.027 feet = 197.517 meters.
Elevation of the zero of the Waiska Bay gauge = 602.099 feet = 183.518 meters.

DESCRIPTION OF BENCH MARKS.

"P. B. M. No. 1 is the top of a copper bolt set in the top of a large bowlder. The bowlder is 12 feet west from the center line of the Duluth, South Shore and Atlantic Railroad, and about 200 yards north of the 3-mile post, and is marked with the letters U. S. B. M., cut into the surface on the east side.

"P. B. M. No. 2 is the top of a copper bolt in the center of a stone that is buried 4 feet deep. The stone is on the west side of the Duluth, South Shore and Atlantic Railroad, 30 feet west from the center line of the track and 45 feet north of the 6-mile post. A tamarac post, 6 inches in diameter, sets upon the stone, and projects about 16 inches above the surface of the ground.

"P. B. M. No. 3 is on the west side of the Duluth, South Shore and Atlantic Railroad, 21.5 feet north from the 9-mile post, and 31 feet west from center of railroad track. It is the top of a copper bolt set in a square stone that is buried about 4 feet deep. A cedar post sets on the stone and projects 16 inches above surface of ground.

"P. B. M. No. 4 is the top of a copper bolt set in a stone that is about 18 inches square and buried 4 feet in the ground. The stone is 34½ feet north from the center line of the Duluth, South Shore and Atlantic Railroad, and 192 feet west from the west end of the railroad bridge across Waiska River, at Bay Mills station, almost due north from the frog on the branch line turning out to Waiska Bay. A cedar post 6 inches in diameter sets upon the stone and projects 2 feet above the ground. The letters U. S. B. M. are carved in the south side of the post."

SLOPE OF THE RIVER.

The Bay Mills gauge was read daily between 8 and 8:30 a. m. from June 6 to September 9, 1892, inclusive. The elevation of the mean reading from this series of observations, or the mean lake level for this period, equals 601.826 feet above mean sea level. The gauge at the head of the canal at Sault Ste. Marie is read daily at noon. The elevation of the mean reading for the period given above is 601.412 feet above mean sea level, making the slope of the river from the Bay Mills gauge to the head of the canal 0.414 feet, or 0.037 feet per mile, the distance between the two gauges being in the most direct line by the channel 11.3 miles. This determination of the slope for this reach is of course not as satisfactory as if the gauges had been read simultaneously, but can be considered a close approximation.

In view of the excellent opportunities offered at Point Iroquois Light-House for establishing a gauge and the possibility of having the light-keeper read it daily for the period of a year at least, I would respectfully recommend the continuing of this line of precise levels from P. B. M. No. 4 to Point Iroquois Light-House. This distance is only 6½ miles over a reasonably good road, representing not to exceed 4 days' work for the ordinary leveling party. The angle party of the primary triangulation could do this work at very small expense while they are occupying △ Iroquois, which is in the vicinity.

Very respectfully, your obedient servant,

E. E. HASKELL,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. Army.

D D D 2.

REEXAMINATION OF ST. LAWRENCE RIVER.

REPORT OF CAPT. SMITH S. LEACH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., July 1, 1894.

GENERAL: I have the honor to transmit herewith my annual report on the reexamination of the St. Lawrence River under an allotment from the appropriation for survey of Northern and Northwestern Lakes, 1894.

Very respectfully, your obedient servant,

SMITH S. LEACH,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

An allotment of $4,275 was made May 2, 1893, and became available on July 1 following. It was based on the estimated cost of a resurvey of the main ship channel for a width of 2,000 feet from Lake Ontario to the foot of the Brockville Narrows, at Morristown, a distance of 40 miles.

Owing to the very uneven conformation of the bed of this part of the St. Lawrence the method of isolated soundings heretofore employed in all hydrographic surveys of a general character was inherently defective, and several shoals not disclosed by the original survey had been reported. It was desired to examine the part of the channel used by deep-draft vessels under such conditions as to leave no possibility of points of rock which could be touched by vessels remaining undiscovered. It was decided to employ the method of continuous sweeping, for many years in use in verifying the removal of rock to certain specified planes, but never before adapted to use on such a large scale. The apparatus devised and the method of working it are described in this report in a general way only, as the work remains unfinished and some details will be modified in future.

A decked scow, 60 by 15 feet, was anchored near mid-channel. Two anchors, one backing the other, were used, and in placing the scow the anchors were let go, the proper length of cable paid out, and the tug made fast alongside, head downstream, and worked at full throttle until the anchors held the strain without dragging. If they failed to hold, they were raised and thrown again a little to one side of their first position.

At the stern of the scow the end of a three-eighth-inch steel wire cable was made fast, and the cable was run out, with can buoys attached at intervals of 250 feet, until 2,750 feet were in the water. This part of the cable was called the permanent radius, and was the shortest line used until near the end of the season, when work was begun at 2,000 and finally at 1,700 feet from the scow. The last distance was found inconveniently short for a full sweep of 2,000 feet, but that or even less will do for narrow channels. At the lower end of this permanent radius a thimble was placed in the cable, and a second cable, called the variable radius, was made fast by a pair of sister hooks. The variable

radius was arranged to take buoys every 175 feet, that being half the length covered at each sweep. This length was selected in order that the eyes permanently wired to the cable to receive the buoys might also be the distance graduations, to avoid the possibility of error.

The sweep was composed of a float or raft of cedar, in sections 20 feet long, and of a line of 2-inch gas pipes of the same length, depending from the float by wire cables. The float sections were strongly and flexibly connected, and the gas pipes were joined by toggles. The joints of the pipe were vertically below those of the float, so that the whole system consisted of a series of flexible parallelograms, each length of pipe being always parallel to the corresponding section of the float. Each of the suspending cables turned 90° over a pulley and was lashed to a cable running the entire length of the float, called the "messenger." By hauling on the "messenger" all the suspending wires were lifted equally and simultaneously, or in other words the line of gas pipe was lifted parallel to its first position, but higher in the water.

Two sweeps were used, having 9 and 10 sections, or 180 and 200 feet length. The tug was placed between them, the shorter one upstream, and having the radius cable attached to its upper end. The axes of the sweeps were parallel with and that of the tug athwart the current. Guy lines to bow and stern of the tug kept the system in the desired position. The space under the boat was filled by a length of pipe dropped over the bow and hanging from the gunwales, and which connected the two sweeps, making a line of pipe 390 feet long up and down stream and 21 feet below the low-water plane. At each swarth the radius cable was lengthened 350 feet, so that there was a lap of 40 feet to insure against gaps. By working the engine ahead or backward the entire system was moved across the channel, running parallel to itself and following the arc of a curve determined by the radius.

The indicating device was simple and very efficient. At every second suspending cable a staff was placed, submerged about 4 feet and attached at its lower end by a spring-clip to the suspending cable. It was pivoted on the float in the plane of the cable and extended 6 feet above the water with a flag at the top. It thus prolonged and made visible the direction of the cable extending from the float to the pipe. It is plain that, if in moving across the channel the pipe met any obstruction, it would be held fast while the float moved on, so that the suspending wire, and consequently the staffs, would be inclined in the direction of motion. The effect was very pronounced, the "bowing" of the staffs being plainly and instantly visible. The boat was stopped in such cases and the messenger hauled in until the staffs resumed the vertical position, which they did suddenly and with a movement not to be mistaken. At that moment the messenger was stopped and the position of a zero point read on a scale which gave directly the depth of the pipes below the datum plane. That depth was recorded as the least depth on the shoal.

At the same time a buoy was dropped on the highest point of the shoal. At first the buoy was located by transit intersections and quite independently of the sweeping apparatus. Observation of the accuracy with which the striking of known shoals could be predicted inspired such confidence in the sweep as a position indicator that one transit cut was abandoned, and locations were made by the arc described by the point of the sweep where the shoal struck and one transit observation. Under the latter method the transit station was always chosen so as to rake the channel, thus making the lateral, or most important coordinate, depend wholly on the transit.

To check against any error from the dragging of the scow anchor during the sweeping a tell-tale buoy was anchored alongside the scow, which showed any movement of the latter by casual observation.

Preparations were begun early in July, and the party reached the point of beginning work at Sister Island on the 21st. After many vexatious delays, due to storms, discourtesy of captains of vessels, the novelty of the undertaking, and the incompetence of the crew of the chartered tug the work was closed on September 19 at the head of Brockville Narrows, 9½ miles from the point of beginning. In this distance 14 new shoals were discovered, the positions of which were reported immediately after the close of fieldwork.

Money statement.

July 1, 1893, amount allotted, May 2, 1893		$4,275.00
June 30, 1894, amount expended during fiscal year		4,072.57
July 1, 1894, balance unexpended		202.43
July 1, 1894, returned to Treasurer, U. S., January 20	$162.43	
July 1, 1894, returned to Treasurer, U. S.	40.00	
		202.43

DDD 3.

ANNUAL WATER LEVELS OF THE NORTHERN AND NORTHWESTERN LAKES.

Tri-daily observations were made at Charlotte and at Oswego, N. Y., on Lake Ontario, from July 1, 1893, to June 30, 1894; at Erie Harbor, Pa., Ashtabula and Cleveland, Ohio, and Monroe, Mich., on Lake Erie; at Milwaukee, Wis., on Lake Michigan; and at Escanaba, Mich., on Green Bay, from July 1 to December 16, 1893, and from March 19 to June 30, 1894.

Daily observations were made at Sand Beach, Mich., on Lake Huron, and at Sault Ste. Marie and Marquette, Mich., on Lake Superior, from July 1, 1893, to June 30, 1894.

The accompanying table is a continuation of that published in the Annual Report of the Chief of Engineers for 1893, Part VI., p. 4381:

Monthly mean of water levels for the several stations below the planes of reference adopted in 1876.

Stations	1893.						1894.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
Charlotte	2.05	2.65	2.01	3.35	3.85	4.04	3.69	3.47	3.10	3.03	2.67	[illegible]
Oswego	2.00	2.53	2.60	3.32	3.73	3.65	3.54	3.36	3.06	3.01	[illegible]	2.30
Erie	1.96	2.45	2.74	2.90	3.11	3.11	3.01	3.20	3.21	2.96	2.53	2.01
Ashtabula	2.04	2.50	2.77	3.10	3.31	3.31	3.14	3.25	3.23	2.93	2.62	2.11
Cleveland	2.16	2.50	2.88	3.23	3.63	3.55	3.27	3.30	3.36	2.96	2.57	[illegible]
Monroe	1.86	2.14	2.53	3.05	3.55	3.51	3.06	3.11	3.07	2.56	2.30	[illegible]
Milwaukee	3.39	3.56	3.88	4.02	4.41	4.48	4.47	4.44	4.16	4.00	[illegible]	[illegible]
Escanaba	3.63	3.87	4.11	4.18	4.45	4.69	.....	.....	4.34	4.27	[illegible]	3.51
Sand Beach	3.50	3.64	3.93	4.14	4.37	4.57	4.02	4.01	4.46	4.23	[illegible]	3.51
Marquette	2.84	2.78	2.87	2.96	3.00	3.20	3.45	3.63	3.54	[illegible]	2.61	2.33
Sault Ste. Marie	2.808	2.721	2.854	2.913	2.968	3.504	3.725	[illegible]	[illegible]	[illegible]	[illegible]	2.316

Place.	Notes.	Time.	Variation.
Amherstburg, inside mouth of Detroit River.	Gauge maintained by Gen. Poe; showed extreme at 4 p. m., and nearly the same at 11 a. m. to 5:30 p. m.	4 p. m.....	—5.0
Monroe............	Light-keeper measured at noon, —6.2 feet, and thinks it was about 0.6 to 1.0 foot lower in the afternoon.	p. m	—6.8
Toledo............	Measured by writer at Adams street, 5 miles from bay....	3:30 p. m..	—6.8
	Estimate at mouth of river, by appearance of banks......	5 p. m.....	—7.3
	Estimate by light-keeper at main crib in bay............	4 p. m.....	—6.8
West Sister Island ..	Light-keeper walked dry-shod around the pier, where depth at mean level is about 6 feet.	p. m	—5.3
Green Island	Light-keeper says 5½ feet below usual; could have walked around pier but for sea.	p. m	—5.3
Sandusky...........	Inspector's estimate at pier, —2.8 feet. Crib light keeper took sounding in boat house; sounding afterward at known stage gives—	4 p. m.....	—2.5
Huron	Light-keeper says at least 3 feet below ordinary; others same; could walk half way to light-house; soundings show—	p. m	—2.8
Vermillion..........	Light-keeper estimated 1 foot below bottom of gauge.....	p. m	—2.3
Black River..........	Inspector's estimate, 3 feet or more below mean level; others, 4 feet.	p. m	—2.8
Cleveland...........	Regular gauge reading at 12 and 6 o'clock, each	12 m..... 6 p. m.....	—1.2
Fairport	All say very low; light-keeper thinks 8 to 10 inches below former level.	....	—1.0
Ashtabula	Inspector's gauge: Noon, —0.1; 6 p. m., —1.3	....	—1.3
Conneaut............	Inspector's gauge: Noon, 3.4; 4 p. m., +3.4.............	12 m..... 4 p. m.....	+3.4
Erie	Gauge reading furnished by Maj. Ruffner as extreme.....	1 p. m.....	2.6
Buffalo	......do..	10 a. m....	5.3

It is also to be noted that both Erie and Buffalo show a minimum gauge of —0.8 and —2.8, respectively, at 2 a. m., giving a range of 8.1 at Buffalo during this storm. It will further be noted in the weather record below that at Buffalo the wind was from the eastward until 2 a. m., and about the same at Erie.

A tracing accompanies this report showing a contour map of Lake Erie and a profile of the water-surface curve along its south shore.

During this storm the weather conditions, as courteously furnished me by the various observers, were as follows:

Toledo.—Light easterly winds on 13th, rain in evening. Wind backed to north and northwest about midnight, increasing in force, and blew from northwest continuously till 5 p. m., 15th, when it became variable and dropped to 6-mile velocity. Maximum velocity 38 miles northwest at 10:30 a. m., 14th; general velocity, 20 to 30 miles northwest; minimum barometer, 28.46, 2 a. m., 14th.

Sandusky.—Easterly winds, 13th, light. Wind increased and backed to northeast in afternoon. High westerly winds from 2 p. m. to midnight, 14th, and continued till evening, 15th, when shifted to northerly.

Cleveland.—Barometer, midnight 13th, 28.33. At 7 p. m., 13th, increasing southeast wind had backed to northeast 27 miles. At 8 p. m. backed to northwest and increased to 32 miles; backed to southwest 35 miles and reached 46 miles west at 2 a. m., 14th, and 48 southwest at 2:40 p. m., 14th. Minimum barometer 28.20 at 2 a. m., 14th, then rose steadily. Gale continued on 15th from southwest and northwest 41 miles maximum at 2:50 p. m.

Erie.—Wind southeast forenoon of 13th backed to northeast in afternoon. Barometer fell rapidly. Windstorm began early in morning, maximum 34 miles southeast at 4:15. Another windstorm began at 8:30 p. m. and reached maximum of 42 southwest at 10:40 a. m., 14th. High wind began 5:30 a. m., velocity 30 to 35 miles, maximum 42 southwest. Abated after 2:30 p. m., 15th.

Buffalo.—From 5 p. m., 13th, to 2 a. m., 14th, barometer fell 1.05 reaching 27.89, the lowest known here. Wind shifted from northeast to southwest at 3 a. m. and blew a gale till after midnight, 14th, maximum 61 miles southwest at 4:10 p. m., 13th. Gale continued till 4 p. m., 15th.

This storm is noted by the Weather Bureau to have been a typical West India cyclone, developing east of the West Indies. It was one of the exceptional cases, when such a storm passes inland, the storm center being near Charleston on morning of 13th with 60-mile velocity, immediately west of Washington, evening of 13th, 38 to 48 miles velocity, thence passing rapidly over Buffalo and being north of Lake Ontario on morning of 14th. A very steep gradient existed on morning of 14th over the whole country east of Missouri River, which was not dissipated until evening of 15th. Ordinarily all storms approach this region from the westward, so that the gale does not commence at east end of the lake quite as early as at west end. In this case, its whole fury struck Lake Erie over its entire length at once. Its

unusal course also produced the erratic phenomenon of a "backing" wind holding steadily from one direction (see Toledo record) for forty hours. Many disastrous wrecks occurred, and it is worthy of note that several of the worst were in the vicinity of the "Narrows," before mentioned, between Long Point and the American shore near Erie and Dunkirk. The steamers *Dean Richmond* and *Wocokea* and the schooners *C. B. Benson* and *Riverside* were all lost during this storm, and all in the same locality—at these "Narrows." Seven lives were lost with each of the schooners, which were considered to be seaworthy boats, as both were in the grain trade. Not a soul was saved from the *Richmond* and but three from the *Wocokea.*

CONCLUSIONS.

It will be observed that while few of the heights are accurate, they carry sufficient reliability to warrant a general discussion of the matter in the light of this crude data, and the hope that it will lead to the obtaining of more definite knowledge and perhaps more sound conclusions. A discussion of other points of interest than these touched upon in this report, though tempting, is, I feel, hardly justified by the data now at hand.

It must also be noted that all data we have was recorded along the south shore of the lake and that the times of record are not coincident, though generally nearly so.

Following now the profile of water and surface in connection with the above data we find that in the West Basin the fall in the funnel-shaped end, containing Monroe and Toledo, was 6.8 feet; in the open it was 5.3 feet. In the main basin, immediately we pass the Island barrier, the fall was but 2.6 feet for all points until Cleveland is reached at the widest part of the lake. Here we find a fall of but 1.2 feet, and practically the same at Ashtabula. Between Ashtabula and Conneaut, a distance of 13 miles, we meet a solid wall of water 4.7 feet high, there having been a rise of 3.4 feet at Conneaut. At Erie the rise was 0.8 foot less than at Conneaut, and at Buffalo the highest point reached was 5.3 feet.

The question now at once arises, do these surface heights along the south shore correctly represent the heights of water in the lake? Assuming it to be so, that is, that the surface is level on each line normal to the shore, then the surplus water in the eastern end of the lake should be about equal to the deficiency in the west end. We find the line of no variation from the normal stage before and after the storm to have been between Ashtabula and Conneaut. The area west of this line is approximately 7,000 square miles, that east of it, 3,000 square miles. In order to make the two quantities equal, the proportion of fall to rise should be as 3 to 7. The record of fall being more numerous, covering larger territory and to a fair extent agreeing among themselves, we may assume a fall of 5.3 feet over 1,200 square miles, 2.6 feet over 1,800 square miles, 1.2 feet over 4,000 square miles, to equal a fall of 2.3 feet over 7,000 square miles; which would give, if our assumption is correct, an average rise of $\frac{7}{3}$ of 2.3 feet = 5.4 over 3,000 square miles. This is not borne out by the data, as it is as large as the maximum height at Buffalo, and twice as large as that at Erie. To show its absurdity, we have really an average rise of perhaps 3.7 feet over 3,000 square miles, which leaves unaccounted for a body of water amounting to 16,000,000,000 cubic feet, enough to supply the ordinary outflow of Niagara for 20 hours. This amount is beyond that already accounted for by the recorded rise at Buffalo, which by itself would scarcely double the outflow even while it lasted. When we consider the pressure which must have existed in connection with the change of elevation of 4.7 feet in 13 miles between Ashtabula and Conneaut, and consider also the immense volume of water displaced west of them and not found to the eastward, it suggests the idea of an enormous eddy or swirl, more or less forcible, in that portion of the lake, the current setting down along the south shore and up along the Canadian side. The observations, though crude, seem to show conclusively that the surface of the lake is not level on the normal lines, but is much higher on the north shore. This is borne out by the fact before mentioned that during the height of the gale there is invariably a reflex current into the west point of the lake, too strong to allow of the belief that it is caused by the gravity of the "piled up" water overcoming the force of the wind. It is a fact that most of the Lake Erie wrecks during a westerly gale are in the vicinity of the "Narrows." In an easterly gale, when these peculiar conditions do not exist, there is seldom a loss in that region.

Is it not possible that in these serious storms there are forces at work for destruction with which we are not familiar, and that a proper study would give the means for combatting them successfully?

I beg leave to suggest that the line of thought here touched upon is important enough to warrant further and more accurate study on the basis of definite data. If the conditions here suggested do actually exist, it will be of vast importance to the navigation interests to know of them; and in order to gain the information for a more thorough and accurate discussion, I respectfully recommend that steps be taken to have all light-keepers on Lake Erie record the height of water three times

Place.	Notes.	Time.	Variation.
Amherstburg, inside mouth of Detroit River.	Gauge maintained by Gen. Poe; showed extreme at 4 p. m., and nearly the same at 11 a. m. to 5:30 p. m.	4 p. m	−5.0
Monroe	Light-keeper measured at noon, −6.2 feet, and thinks it was about 0.6 to 1.0 foot lower in the afternoon.	p. m	−6.8
Toledo	Measured by writer at Adams street, 5 miles from bay	3:30 p. m.	−6.8
	Estimate at mouth of river, by appearance of banks	5 p. m.	−7.3
	Estimate by light-keeper at main crib in bay	4 p. m.	−6.8
West Sister Island	Light-keeper walked dry-shod around the pier, where depth at mean level is about 6 feet.	p. m	−5.3
Green Island	Light-keeper says 5½ feet below usual; could have walked around pier but for sea.	p. m	−5.3
Sandusky	Inspector's estimate at pier, −2.8 feet. Crib light keeper took sounding in boat house; sounding afterward at known stage gives—	4 p. m	−2.5
Huron	Light-keeper says at least 3 feet below ordinary; others same; could walk half way to light-house; soundings show—	p. m	−2.8
Vermillion	Light-keeper estimated 1 foot below bottom of gauge	p. m	−2.3
Black River	Inspector's estimate, 3 feet or more below mean level; others, 4 feet.	p. m	−2.8
Cleveland	Regular gauge reading at 12 and 6 o'clock, each	12 m. 6 p. m.	−1.2
Fairport	All say very low; light-keeper thinks 8 to 10 inches below former level.		−1.0
Ashtabula	Inspector's gauge: Noon, −0.1; 6 p. m., −1.3		−1.3
Conneaut	Inspector's gauge: Noon, 3.4; 4 p. m., +3.4	12 m. 4 p. m.	+3.4
Erie	Gauge reading furnished by Maj. Ruffner as extreme	1 p. m.	2.6
Buffalo	do	10 a. m.	5.3

It is also to be noted that both Erie and Buffalo show a minimum gauge of −0.8 and −2.8, respectively, at 2 a. m., giving a range of 8.1 at Buffalo during this storm. It will further be noted in the weather record below that at Buffalo the wind was from the eastward until 2 a. m., and about the same at Erie.

A tracing accompanies this report showing a contour map of Lake Erie and a profile of the water-surface curve along its south shore.

During this storm the weather conditions, as courteously furnished me by the various observers, were as follows:

Toledo.—Light easterly winds on 13th, rain in evening. Wind backed to north and northwest about midnight, increasing in force, and blew from northwest continuously till 5 p. m., 15th, when it became variable and dropped to 6-mile velocity. Maximum velocity 38 miles northwest at 10:30 a. m., 14th; general velocity, 20 to 30 miles northwest; minimum barometer, 28.46, 2 a. m., 14th.

Sandusky.—Easterly winds, 13th, light. Wind increased and backed to northeast in afternoon. High westerly winds from 2 p. m. to midnight, 14th, and continued till evening, 15th, when shifted to northerly.

Cleveland.—Barometer, midnight 13th, 28.33. At 7 p. m., 13th, increasing southeast wind had backed to northeast 27 miles. At 8 p. m. backed to northwest and increased to 32 miles; backed to southwest 35 miles and reached 46 miles west at 2 a. m., 14th, and 48 southwest at 2:40 p. m., 14th. Minimum barometer 28.20 at 2 a. m., 14th, then rose steadily. Gale continued on 15th from southwest and northwest 41 miles maximum at 2:50 p. m.

Erie.—Wind southeast forenoon of 13th backed to northeast in afternoon. Barometer fell rapidly. Windstorm began early in morning, maximum 34 miles southeast at 4:15. Another windstorm began at 8:30 p. m. and reached maximum of 42 southwest at 10:40 a. m., 14th. High wind began 5:30 a. m., velocity 30 to 35 miles, maximum 42 southwest. Abated after 2:30 p. m., 15th.

Buffalo.—From 5 p. m., 13th, to 2 a. m., 14th, barometer fell 1.05 reaching 27.89, the lowest known here. Wind shifted from northeast to southwest at 3 a. m. and blew a gale till after midnight, 14th, maximum 61 miles southwest at 4:10 p. m., 13th. Gale continued till 4 p. m., 15th.

This storm is noted by the Weather Bureau to have been a typical West India cyclone, developing east of the West Indies. It was one of the exceptional cases, when such a storm passes inland, the storm center being near Charleston on morning of 13th with 60-mile velocity, immediately west of Washington, evening of 13th, 38 to 48 miles velocity, thence passing rapidly over Buffalo and being north of Lake Ontario on morning of 14th. A very steep gradient existed on morning of 14th over the whole country east of Missouri River, which was not dissipated until evening of 15th. Ordinarily all storms approach this region from the westward, so that the gale does not commence at east end of the lake quite as early as at west end. In this case, its whole fury struck Lake Erie over its entire length at once. Its

daily, together with the wind directions and velocities, and to have special instructions issued that they shall note any unusual conditions of weather or water. In any prolonged and severe storm, particularly those of April and October, they shall carefully note the extremes of water level and wind.

To be of any service in a further consideration of this subject, the Canadian authorities should be requested, through the proper channels, to cooperate fully.

I am thoroughly impressed with the idea that such observations will bear fruit of some importance at very slight expense.

Very respectfully

WM. T. BLUNT,
Assistant Engineer.

Lieut. Col. JARED A. SMITH,
Corps of Engineers, U. S. A.

WATER LEVEL OF LAKE MICHICAN.

REPORT OF MAJ. JAMES F. GREGORY, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 6, 1894.

GENERAL: I have the honor to forward the accompanying plate* on which is continued the water level curve on Lake Michigan for the fiscal year ending June 30, 1894, and to inclose a letter from Lieut. C. H. McKinstry, Corps of Engineers, giving the monthly mean water levels during the year.

* * * * * * *

Very respectfully, your obedient servant,

JAMES F. GREGORY,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF LIEUT. C. H. M'KINSTRY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 6, 1894.

SIR: I have the honor to transmit herewith the water-level curves* for Lake Michigan for the year 1893-'94, from tridaily observations taken at Milwaukee, Wis., and Escanaba, Mich., with monthly reports of observers.* Observations at Milwaukee were taken continuously throughout the year; at Escanaba they were discontinued from December 17, 1893, to March 18, 1894.

Following are the monthly means (feet and decimals below plane of reference) from which the curves were plotted, the plane of reference being "high water of 1838."

Stations.	1893.						1894.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
Milwaukee, Wis	3.39	3.56	3.88	4.02	4.41	4.48	4.47	4.44	4.18	4.03	3.49	3.33
Escanaba, Mich	3.63	3.87	4.11	4.18	4.45	a4.60	......	......	b4.34	4.27	3.97	3.54

a To December 16, inclusive. *b* From March 19, inclusive.

The "reduction to the plane of reference" at Milwaukee is —0.61 foot; that is, the zero of the gauge is 0.61 foot above the plane of reference. At Escanaba the "reduction to the plane of reference" was determined in 1877 to be —0.76 foot

* Omitted.

(Report of 1876, Vol. II, p. 84; 1877, Vol. II, p. 1194), and the monthly means from that time until June, 1882, were corrected (reduced) by that amount. The observations from July, 1882, to June, 1887, were further reduced by 0.187 foot. (Report of 1887, p. 2417.) The observations from July, 1887, to June, 1892 (published in Report of 1892, p. 3130), and the observations for 1892-'93 were reduced by 0.76 only. This was plainly an oversight, and I would respectfully suggest the desirability of making a further correction of — 0.187.

In July, 1893, the zero at Escanaba was tested by leveling from bench marks in the vicinity and was found to be 0.902 foot above the plane of reference. This correction (0.902 foot) was used in reducing the observations of 1893-'94.

Very respectfully, your obedient servant,

C. H. McKinstry,
First Lieutenant of Engineers.

Maj. James F. Gregory,
Corps of Engineers, U. S. A.

WATER LEVEL OF LAKE ONTARIO.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

(For letter of transmittal see Appendix P P.)

Permanent gauges are established at Oswego Harbor and at Charlotte Harbor (at the mouth of the Genesee River), and each has been read three times per day during the year. They show the lake level to have been lower than usual at similar dates throughout the year.

OSWEGO GAUGE.

This gauge was established in 1837 by the United States Engineer at Oswego at plane of extreme low water. The lake level has several times since been at this plane, but never below it. The gauge is cut on the harbor face of the stone pier at the foot of West Third street, and is indicated by an iron plate cut to feet and tenths and bolted beside it.

The zero of the gauge is referred to the top of an iron bolt in top of masonry of old Government stone pier 0.5 foot from east face of pier. 3½ feet north of its intersection by the crib-work wharf, foot of the United States reservation at the foot of West Third street, Oswego, marked U. S. B. M. This bench mark is 7.75 feet above zero of gauge.

The zero of gauge, on plane of extreme low water, is 244.21 feet above mean tide at New York. (See p. 609, Prof. Papers 24.)

Readings were taken daily at 7 a. m., 1 p. m., and 6 p. m. with observations of direction and force of wind. The daily means were taken, and a mean of three taken as a monthly mean.

Oswego monthly means above extreme low-water level.

1893.	Feet.	1894.	Feet.
July	2.98	January	1.14
August	2.45	February	1.62
September	2.18	March	1.92
October	1.66	April	1.97
November	1.25	May	2.15
December	1.13	June	2.68

Oswego monthly means below plane of reference for Lake Ontario water levels.

1893.	Feet.	1894.	Feet.
July	2.00	January	3.54
August	2.53	February	3.36
September	2.80	March	3.06
October	3.32	April	3.01
November	3.73	May	2.83
December	3.85	June	2.30

CHARLOTTE GAUGE.

The gauge at Charlotte Harbor was established by the Lake Survey, and is described in the Report of 1876 and in Professional Papers No. 24.

The zero was lowered 4.5 feet in 1883 to coincide with the zero of the Oswego gauge, at plane of extreme low water, and since that date all readings have given heights above extreme low-water level.

The zero is referred to a bench mark on the upper side of the water table of the old (now disused) light-house at Charlotte at the south-southeast angle east of the south window, which bench mark is at 283.23 feet above mean tide at New York, and 39.02 feet above the zero of the gauge, which zero is 244.21 feet above mean tide at New York.

The gauge is cut in feet and tenths in a wrought-iron plate, and is bolted to an oak pile at the northeast angle of the west abutments of the R., W. and O. R. R. drawbridge at Charlotte.

Readings are taken daily at 7 a. m., 1 p. m., and 7 p. m., with observation of direction and force of wind.

The daily means were taken and a mean of these as the monthly mean.

Charlotte monthly means above extreme low-water level.

1893.	Feet.	1894.	Feet.
July	2.93	January	1.29
August	2.43	February	1.51
September	2.07	March	1.88
October	1.63	April	1.95
November	1.13	May	2.12
December	0.94	June	2.59

Charlotte monthly means below plane of reference for Lake Ontario water levels.

1893.	Feet.	1894.	Feet.
July	2.05	January	3.69
August	2.55	February	3.47
September	2.91	March	3.10
October	3.35	April	3.03
November	3.85	May	2.87
December	4.04	June	2.39

APPENDIX E E E.

CONSTRUCTION AND IMPROVEMENT OF ROADS AND BRIDGES IN THE YELLOWSTONE NATIONAL PARK.

REPORT OF MAJ. WILLIAM A. JONES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., July 10, 1894.

GENERAL: I have the honor to submit herewith my report, in duplicate, of operations for the improvement of Yellowstone National Park during the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

The project for this work was adopted in 1883, when the control was placed in the hands of officers of the Corps of Engineers, and consists in the construction and maintenance of about 225 miles of road, with the necessary bridges, culverts, etc. The roads embraced in the project commence at Gardiner, at the north boundary line of the Park, thence to Mammoth Hot Springs; thence to upper Geyser Basin, passing through Norris Geyser and Lower Geyser Basins; thence to the outlet of Yellowstone Lake via Shoshone Lake and the west arm of Yellowstone Lake, crossing the Continental Divide of the Rocky Mountains twice; thence to Yanceys via the Falls and Grand Canyon of the Yellowstone River; thence to Mammoth Hot Springs, completing the so-called belt road, with a circuit of about 145 miles. In addition, there are projected a road from the west boundary line of the Park, passing through Lower Geyser Basin and continued easterly to intersect the road along the Yellowstone River to the Falls; a road from Norris Geyser Basin to the Falls of the Yellowstone; a road from Yanceys to the east boundary line of the Park, and a number of short branch roads and trails from the above-named roads to objects of interest off the main line of travel; in all, 225 miles of new road, about 20 large and 50 small bridges, with many culverts, etc. Estimated cost, as revised in 1889 by my predecessor, $444,779.42.

The act of Congress approved March 3, 1891, changed the project of the part of the belt line between Lower Geyser Basin and Yellowstone

Lake by requiring the road to be built "by the shortest practic route" from Fountain Geyser to the Thumb of the Yellowstone La This change did not materially affect the cost.

The act of Congress approved August 5, 1892, appropriated $45, and provided "that $15,000 of this amount, or so much thereof as m be necessary, may be expended, in the discretion of the Secretary War, for the construction of a road from the Upper Geyser Basin t point on Snake River where it crosses the southern boundary of Park."

Construing this act as the wish of Congress to modify the project adding thereto some 33½ miles of projected road, the estimated cos my predecessor will be considerably increased.

A new estimate of the cost of completing the project was submit January 25, 1894.

Total amount expended to June 30, 1893, including outstanding bilities, $379,779.42.

PROGRESS OF THE WORK.

At the commencement of work upon the project about 160 miles wagon track had been cleared, over which vehicles could, with diffic reach the principal objects of interest in the Park.

This project has now been carried forward to the point that go graded and well drained, roads have been substantially completed o the following lines:

(1) From the north entrance at Gardiner via Mammoth Hot Springs, Norris Basi Upper and Lower Geyser basins.
(2) From Norris Basin via the Grand Canyon to Yellowstone Lake outlet.
(3) From Upper Geyser Basin via the Thumb to Yellowstone Lake outlet.
Total, 127.5 miles.

Besides this there have been abandoned the following short stretc for better locations:

	Mi
At Norris	
At Gibbon	
Marys Mountain road	
At Fountain	

In addition to the above-mentioned completed mileage, the followi mileage of wagon trail (line opened to admit the passage of vehicles, b not graded and but slightly drained) has been in use and kept in tol able repair:

	Mi
Mammoth Hot Springs to east boundary	
Lower Firehole to west boundary	
Total mileage operated	2

In order that the whole situation may be presented in compact sh I will prelude a recital of the operations for the season of 1893 wit general statement of conditions and project, taken from my report operations for the month of November, 1892.

A map is submitted herewith showing:

(1) The location of the various points of interest in the Park which are to be reach by roads under the approved project.
(2) The various stages of completion of these roads.
(3) The work done during the present season.
(4) The work under the project which remains to be done.

* * * * * * *

[For the part of this report here omitted, see report of the Chief of ngineers for the year 1893, pp. 4393–9543.]

SEASON OF 1893.

The following is a résumé, showing the operations for the season of 93:

In the month of April, having sufficient funds in hand for placing e roads in readiness for the traffic which commences in June, I placed small party at work upon repair in Gardiner Canyon. At this point avy slides from the mountain wall of the canyon come upon the road the spring, making the cost of maintenance excessive. At this time e only portion of the system sufficiently free from snow to permit erations was at this point.

Beyond Golden Gate there was generally a depth of at least 5 feet of ow.

About the middle of May I sent out Mr. Charles A. Hunt, United ates overseer, to take local charge of the work during the season, th instructions to place repair parties upon the roads as rapidly as e disappearing snows would permit.

In the meantime Mr. A. E. Burns, one of the watchmen, had been spatched upon a snowshoe expedition to cover the whole system of ads, and report upon the conditions then existing. His report is as llows:

With the exception of a few drifts there is but very little snow between here and lden Gate. The grade around the hill approaching the trestle there is covered th slide rock, but no snow, as the wind sweeps it bare. At the upper end of the stle is a large drift, another much larger at the Falls; the latter extends from the mmit of the cliff on the west clear over the road, and falls for a distance of 50 et. The first bridge on the flat is entirely buried, with the snow lying level away above the rails. Across the flat the snow is from 2 to 4 feet; on Indian Creek idge it is just 4 feet 6 inches, but has blown off considerably on Willow Creek idge. All across the Willow Park the road lies under 4 to 5 feet of snow. om there on to Norris the snow is not deeper than usual at this season, 4 feet. uch of the new road around Norris Hill is covered with drifts which will probably ave the road bed very soft; but about one-third of it is entirely bare, owing to the arm ground. It appeared to me that the approaches to the new bridge at Norris d settled to a considerable extent; if as much as I think, I'm afraid they will wash t at high water; but in this I may be mistaken, as it is hard to tell under so much ow. From Norris to the Virginia Cascade the snow's depth will average about 4 et; from there to the canyon, about 5 feet. The Gibbon River is all open, so that I do t apprehend any danger to the road below the Upper Falls from the ice damming as last spring. I arranged with the care-taker at the Canyon Hotel to watch the ow on the retaining wall round the road above the canyon, and to cut it off if it reatens the road at all. There is no ice at all in the rapids above the Upper Yel-wstone Falls; large snow banks are along the shores and on the larger rocks, but e water, which is rising rapidly, is fast cutting it away. The bridge over the dry aw at the foot of the Canyon Hill is supporting snow 2 feet above the top of the side ils. On the new road across Hayden Valley the snow is of course very deep, the idges over Alum and Trout creeks are covered level with the rails, and the grade p from Trout Creek is one huge drift. On the Continental Divide the snow is so eep that it is impossible for me to form any idea of the roads there. Most of the gnboards we put up from Old Faithful to the West Thumb are under the snow, t least I could only find two, and they were but a few inches above the snow. pring Creek is open most of its length, snow fell there heavily last fall, before there as much frost, thus preventing the creek freezing, and with the little warm weather e have had, the snow over the creek has melted, leaving an open channel. This is ery fortunate, as I believe the washouts there last spring were mostly caused by e dams, which are not likely to occur this time. Between the first bridge on the irehole River (from Spring Creek) and the second the snow is from 20 to 30 feet eep, making the river, which is open, look as though it is flowing through a canyon. I don't think it will be possible to get a team through there before July, unless it is hoveled, or an exceptional period of warm weather arrives.

Around the Upper Basin the snow is going rapidly, and there is but little between that point and the Fountain. From Lower Basin the snow lies from 3 to 5 feet deep, but no very large drifts. On Gibbon Meadows and Elk Park it is from 2 to 3 feet.

Based upon the information derived, I sent out a small party to patrol on snowshoes the road across the Continental Divide, to repair the damages from melting snows in Spring Creek Canyon as fast as they might occur, and otherwise keep me duly informed of anything which might happen.

As a result of the foregoing arrangements, the whole road system was occupied by repair parties nearly as fast as the snow disappeared, and it was placed in a most excellent condition in time for the season's traffic. The system adopted for keeping the roads in repair worked admirably; and as a distinct matter of fact, the roads in the Yellowstone National Park, from the beginning to the end of the season, were never before kept in such thorough and satisfactory condition.

Particular attention is invited to the fact that these repair parties do a great deal of work in the way of surfacing the roads with gravel, and in completing portions of road which have been left unfinished from former seasons.

A considerable portion of the roads was impassable from snow until the middle of June, and the Continental Divide road was not passable from the same cause until about the 1st of July.

During the first week in June Mr. Hunt, with the men in the office, made a survey and location of a portion of the proposed road from Mammoth Hot Springs to the Grand Canyon.

ROAD TO SOUTH BOUNDARY.

This work was executed by contract. In response to a public invitation for proposals the contract was awarded to Oscar Swanson, of Great Falls, Mont., who commenced work about June 20, as soon as the snow permitted him to place his men in the field. He executed his contract satisfactorily and opened the road for a distance of 15.5 miles south toward the boundary. This portion of the line was carefully surveyed, and a reconnaissance made at the close of the season to develop the quantity of work remaining and required to open up the line to the wagon road approach to the south boundary. The road can be opened quickly and at small expense.

BRICK-YARD HILL.

A very difficult piece of road in clay at this point was made over again and surfaced with gravel. The material selected was not suitable, and this surfacing will have to be done again. A gravel suitable for road covering should be of quartzy material and associated with sand and clay or loam sufficiently to fill the interstices of the hard material and act as a matrix when it becomes packed.

NEW APPROPRIATION.

July 1, 1893, the new appropriation for $30,000 became available. Preparation had been made for it by advertising for the delivery of teams and material on that day. Also a site had been selected for a sawmill which was to saw lumber for the season's work and for the large wooden arch bridge above the Upper Falls of the Yellowstone River.

SUPPLIES.

It has been the invariable custom to purchase supplies and hire teams by publicly inviting proposals and purchasing from the lowest bidder, making open market purchases only in cases of emergency.

The bids for teams were as follows:

Name and address of bidder.	Pair, per day.	Four, per day.	Wagon, per day.	Driver, per day.
			Cents.	
H. J. Hoppe, Cinnabar, Mont	$2.10	$4.20	39	$1.33
Chas. Cowell, Gardiner, Mont	3.50	7.00	75	1.50
A. L. Love, Livingston, Mont	3.40	6.80	25	1.35
H. F. Klamer, Mammoth Hot Springs, Wyo	2.20	5.15	35	1.50
Oscar Swanson, Mammoth Hot Springs, Wyo	3.38	6.76	50	1.50
J. A. Hoskins & Co., Butte City, Mont	2.49	4.98	20	1.50
George T. Young, Livingston, Mont	2.60	5.20	25	1.50
Patrick Gillen, Helena, Mont	2.00	....	50	2.50

The bids were lower than ever before on account of the financial disturbance in the country.

WORKING PARTIES.

Five parties were organized and placed in the field on the 1st of July:

(1) One at Norris to complete the new cut-off road at that point.
(2) One at the Upper Falls of the Yellowstone River to complete a very difficult piece of road along the rocky face of the canyon.
(3) The sawmill and bridge crew at the Grand Canyon. This crew worked at logging and running the sawmill for twenty-five days, and was then reorganized to build the big wooden arch bridge above the Falls.
(4) One to proceed to the unfinished beach road on the lake, placing the road in thorough repair, over which it marched on its way in.
(5) A general repair party.

BRIDGE.

About the middle of September the amount of funds set aside for expenditure this season had been nearly expended, and all of the crews were discharged, except the bridge crew. This was held in hopes of getting the bridge finished, but owing to severe weather and snow and ice, which made it difficult and dangerous to work upon the lofty structure, it was deemed advisable to postpone completion until next year.

The road above the Upper Falls was completed and the crew placed upon the road from Grand Canyon to Mammoth Hot Springs via Yanceys.

The road at Norris was completed and the crew placed upon the new road at the Fountain Hotel, which it opened to travel.

The road at the beach was not completed, but it was carried forward to such point that it can easily be completed in time for the bulk of next season's traffic.

The repair party made efficient repairs over the road between Norris, via the Grand Canyon and Lake, to the Thumb, and was merged with crew at the beach.

SAWMILL.

The sawmill was kept in operation for sixteen and a half days, turning out an average of 5,800 feet, B. M., per day. An attempt was made to get out dry timbers for certain members of the bridge from standing burnt trees. This involved much trouble and increased the cost of the timber somewhat.

BRIDGES.

A large trestle bridge was built near the Grand Canyon by the bridge crew, but not quite completed.

The bridge over the Lamar River having gone out with the spring freshets a crew was sent in to rebuild it. This crew also did some repair work on the road to east boundary of the Park.

WORK ACCOMPLISHED.

Organization.—Six working parties, completely equipped for field service with tents, tools, teams, and provisions, in local charge of Mr. Charles A. Hunt, overseer, assisted by one timekeeper and two receivers of material.

SUPPLY SYSTEM.

All supplies were assembled at Mammoth Hot Springs as a distributing depot. They were shipped in by rail to Cinnabar, Mont., and from thence hauled 8 miles by wagon to the depot. From the depot the distribution was made by wagons to the working camps, in a systematic and continuous manner. The distances hauled over by wagons were as follows:

	Miles.
To Norris	28
To Fountain	48
To Grand Canyon	32
To Beach	64

* * * * * * *

SUMMARY.

New road completed	miles..	5.4
New road opened to travel (nearly completed)	do....	16.75
Earth excavation	cubic yards..	32,500
Rock excavation	do....	6,350
Retaining wall	do....	1,005
Timber cleared and grubbed	acres..	63.65
Large long span bridges (nearly)		2
Small bridges (nearly)		9
Whole road system kept in good order and repair	miles..	212.5

Well painted cedar mile posts and sign boards placed over the whole of the belt system of roads except between Norris and Upper Basin.

Permanent granite monuments set up at the lake outlet to mark the meridian and astronomical point determined by the U. S. Coast and Geodetic Survey.

EXPENDITURES.

Trial balance.

Labor	$14,769.94
Team hire	7,986.41
Subsistence stores	3,544.54
Railroad transportation	1,817.61
Material	2,124.22
Swanson's contract	5,149.85
Telegrams	29.00
Miscellaneous	119.97
St. Paul office	520.00
Total	36,061.54

EXPENDED UPON VARIOUS PORTIONS OF THE WORK.

Road construction.			
New road—			
To South Boundary		$5,270.43	
Near Norris		1,760.21	
Near Fountain		1,856.50	
On lake shore (beach)		4,911.08	
Above Upper Falls of the Yellowstone River		3,737.32	
To Inspiration Point, being a part of the main belt line from Grand Canyon to Mammoth Hot Springs		1,440.37	
			$18,975.91
Large bridges.			
Wooden-arch bridge at Upper Falls:			
Foundation	$361.29		
Iron	1,184.98		
Timber	2,566.24		
Erection	3,956.76		
Office and incidentals	1,543.18		
		9,612.45	
Trestle near Lookout Point		256.89	
Crib work and round timber on Lamar River		846.96	
			10,716.30
General repairs.			
Between Gardiner and Golden Gate		971.57	
Between Golden Gate and Brick-yard Hill		1,122.51	
Between Brick-yard Hill and lake		2,025.20	
Between Norris and Thumb via Fountain		2,250.05	
			6,369.33
			36,061.54
New road			18,975.91
Bridges			10,716.31
Repairs			6,369.33
			36,061.54

Maps are submitted as follows:
(1) Road map.
(2) Wooden-arch bridge.*
(3) Crib-work bridge over Lamar River.*

In the St. Paul office there has been completed a general relief map of the Park and the Forest Reserve, compiled from latest data. (Scale, 1 inch = 2 miles.)

The subjoined report on the Park bridges is the result of a special examination ordered by me, and is here entered for record.

FLOOD AND WASHOUTS, SPRING OF 1894.

During my inspections in April and May, 1894, I became aware of an extraorninary volume of snow in the mountains that drain through the Park, that fell largely during the months of February and March. Early in May this snow had hardly commenced to move, and hence it was apparent that it would go off very rapidly, creating unusual floods, and I accordingly made such disposition as was possible to minimize the damage. A patrol party on snowshoes was placed in Spring Creek Canyon, and when the flood came they were able to control it completely, and no damage was done to the roadway through this weakest point in our line. Another party was placed in Gardiner Canyon, and another was put out where it could go either to Gibbon Canyon or Virginia Cascade and at the same time attend to repairs that were imme-

* Omitted.

diately required. Another party was sent to watch the bridge over Lamar River, which was in a very critical condition.

When the crash came it was far more severe than had been anticipated, and the mountain torrents, along the banks of which our roads frequently run, rose to heights far above any previous record. In some cases, where the banks of the torrents were the retaining walls of the road, the latter was more or less submerged and the retaining wall carried away. In Gardiner Canyon bowlders of great size could be seen rolling down the bed of the stream. Here the greatest damage was done. About 600 feet of retaining wall was carried away, and a bridge located in a double bend caused the river to cut a new channel, leaving the bridge along the bank on one side of it.

In Virginia Canyon the roadway was entirely submerged, causing a damage that can be entirely remedied in about ten days. In Gibbon Canyon three washouts of the retaining wall occurred, which can be repaired fully in ten or twelve days.

The bridges withstood the flood in a remarkable way. Several were wholly or partly submerged in raging torrents which ran around their extremities. The one over Lamar River spans a stream 156 feet in width and the current, running at least 12 miles per hour, brought large quantities of driftwood upon it. The watchman stationed here, with such assistance as he could get from Soda Butte ranch, was kept at work night and day cutting away this driftwood and letting it pass. The water ran over the top of this bridge and around both ends of it. The small rustic bridges across Blacktail Creek and East Gardiner River went out, but were replaced within a day.

Considering the great mileage of the Park road system and its frequent location in gorges and canyons alongside the mountain streams, the damage done was comparatively slight. The passage of vehicles was not suspended for more than a single day, and within ten days travel was unimpeded over the whole road system; the Gardiner Canyon bridge being replaced by a low stringer bridge and a ford. It may safely be claimed that the damage was minimized by the precautions taken.

Amount expended during fiscal year ending June 30, 1894, including outstanding liabilities, $36,000.

ABSTRACT OF ALLOTMENTS AND APPROPRIATIONS.

Allotments.

Under the appropriations of—	
1883	$23,570.03
1884	23,000.02
1885	23,209.37

Appropriations.

By act approved—	
August 4, 1886	20,000.00
March 3, 1887	20,000.00
October 2, 1888	25,000.00
March 2, 1889	50,000.00
August 30, 1890	75,000.00
March 3, 1891	75,000.00
August 5, 1892	45,000.00
March 3, 1893	30,000.00
Total	409,779.42

Money statement.

July 1, 1893, balance unexpended	$38,810.56
June 30, 1894, amount expended during fiscal year	37,170.41
July 1, 1894, balance unexpended	1,640.15
July 1, 1894, outstanding liabilities	1,640.15
Amount appropriated by act of August 18, 1894	30,000.00
Amount available for fiscal year ending June 30, 1895	30,000.00
Amount (estimated) required for completion of existing project	*130,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	150,000.00

REPORT OF MR. CHARLES A. HUNT, OVERSEER.

UNITED STATES ENGINEER OFFICE,
Mammoth Hot Springs, Wyo., July 25, 1893.

MAJOR: I have the honor to make the following report upon the condition and character of bridges in Yellowstone National Park. The first bridge upon entering the Park is at the crossing of the Gardiner River.

Location of bridge.	Length.	Width.	Character.	Condition.
	Feet.	*Ft. in.*		
At the crossing of Gardiner River, 1½ miles from the town of Gardiner.	88	14 4	Log bridge, except flooring; 3-span King truss.	Good.
Over dry run, 2½ miles from Gardiner.	22	14 4	Log; 1 span, with support in middle.	Good, except needs flooring.
Over Gardiner River, 3¼ miles from Gardiner.	106	14 4	3 span King truss; log, except floor.	Good.
At Golden Gate, 3 miles from Mammoth Hot Springs.	220	14 4	Half-bent trestle, anchored into cliff.	Do.
Over small creek at top of Golden Gate Hill, 3½ miles from Mammoth Hot Springs.	16	14 4	Log or pole bridge, with plank flooring.	Do.
Over small creek outlet of Swan Lake, 4½ miles from Mammoth Hot Springs.	16	14 4	1-log span, with plank floor.	Do.
Over Indian Creek, or Gardiner River, 7 miles from Mammoth Hot Springs.	67	14 4	Queen truss; 45-foot span, approach of 22 feet.	Do.
Over Willow Creek, 7½ miles from Mammoth Hot Springs.	30	14 4	King truss	Good.
Over small creek emptying into Willow Creek, a little over 7½ miles from Mammoth Hot Springs.	16	14 4	One long span; plank floor	Do.
Over Willow Creek, less than 10½ miles from Mammoth Hot Springs.	16	14 4	......do	Do.
Over Obsidian Creek, near Obsidian Cliff, 11½ miles from Mammoth Hot Springs.	30	14 4	King truss	Do.
Two bridges on old road at Norris, (1).	30	14 4	Log; King truss; plank floor.	Fair.
(2)	20	14 4	Log; log span; plank floor	Fair.
Over Gibbon River at Norris, 19¾ miles from Mammoth Hot Springs.	30	14 4	King truss; pole floor	Good; built 1892.
One 8-foot, one 16-foot, and two 32-foot log bridges, built in 1884 over small creeks, near hot springs and about 1 mile down Gibbon Canyon from Gibbon Meadows. All in fair condition.				

* According to estimate of 1889, which was too low.

Location of bridge	Length.	Width.	Character.	Condition.
	Feet.	*Ft. in.*		
Over Gibbon River, about 2¼ miles above Gibbon Falls.	84	14 4	Queen truss made from hewed timber.	Good; built 1884
Over Gibbon River, about 1¾ miles above Gibbon Falls.	96	14 4	Trestle of sawed timber......	Good; built 1889.
Over Gibbon River, about 1 mile below Gibbon Falls.	48	14 4	Log bridge with wooden piers and abutments.	Good; built 1892.
Over Firehole River, about 1¼ miles toward old Firehole Hotel, from Excelsior Geyser on old road.	70	14 4	Two span; King truss	Good.
Over Firehole River, about 1 mile from Excelsior Geyser toward Upper Basin.	112	14 4	Low trestle of 7 bents........	Good; hewed timber; built 1886.
Over Firehole River, about 1 mile from Old Faithful toward Fountain.	75	14 4	Two spans with approach....	Good.
Over Firehole, about ¾ mile from Old Faithful toward West Thumb.	35	14 4	Queen truss	Good; built 1892.
Over Firehole River, about 2¼ miles from Old Faithful toward West Thumb.	57	14 4	Double King truss of sawed timber.	Do.
Over Firehole River, about 3¼ miles from Old Faithful toward West Thumb, near mouth of Spring Creek.	29	14 4	King truss of sawed timber ..	Do.
Over ravine, about 9¼ miles from Old Faithful toward West Thumb.	64	14 4	Log piers and abutments; decked with sawed timber.	Good; built 1891.
Over small run, about 1¼ miles from junction of roads at West Thumb toward Upper Basin.	64	14 4	Log trestle with plank floor ..	Good; needs hand rails; built 1891; needs more plank on deck.
Over head of ravine, about ¾ mile from junction of roads at West Thumb toward Upper Basin.	64	14 4	......do	Good; needs hand rails; built 1891.
At outlet of creek, about 2 miles from junction of roads at West Thumb toward Lake Hotel.	32	14 4	Low trestle; sawed timber..	Do.
Over creek, about 3¾ miles from junction of roads at West Thumb toward Lake Hotel.	16	14 4	One span; log abutments with plank floor.	Good; built 1891.
Over creek, about 4 miles from Thumb toward Lake Hotel.	16	14 4	......do	Do.
Over creek, about 9¼ miles from Thumb toward Lake Hotel.	160	14 4	Trestle, about 50 feet high....	Do.
Over creek, about 10¾ miles from Thumb toward Lake Hotel.	104	14 4	Trestle	Do.
Over run, about 11¾ miles from Thumb toward Lake Hotel.	16	14 4	One span; sawed timber abutments.	Good; needs new hand rails.
Over small run, about 14¼ miles from Thumb toward Lake Hotel.	16	14 4	......do	Good.
Over small run, about 15¾ miles from Thumb toward Lake Hotel.	32	14 4	Two bents; abutments sawed timber.	Good; needs new hand rails.
Over creek, about 16 miles from Thumb toward Lake Hotel.	16	14 4	One span; sawed timber abutments.	Do.
Over outlet of creek into Bridge Bay, about 16¼ miles from West Thumb toward Lake Hotel.	16	14 4	......do	Good.
Over creek, about 1¼ miles from Lake Hotel toward Thumb.	96	14 4	Trestle......................	Good; needs new hand rails.
Over creek, about ¾ mile from Lake Hotel toward West Thumb.	32	14 4	Two spans and bent of sawed timber; two abutments.	Good.
Over small run, about ¼ mile from Lake Hotel toward Thumb.	16	14 4	One span; sawed timber.....	Good; hand rails need repairing.
Over small run, about 500 feet from Lake Hotel.	16	14 4	......do	Do.
Over creek, about ¾ mile from Lake Hotel toward canyon.	10	14 4	One span with sawed timber abutments.	Good; built 1891.
Over small creek, about 2 miles from Lake Hotel toward canyon.	20	18	Log	Do.
Over small creek, about 2¼ miles from Lake Hotel toward canyon.	16	14 4	......do	Do.

Location of bridge	Length.	Width.	Character.	Condition.
	Feet.	*Ft. in.*		
Over dry run, about ¼ mile from rapids toward Lake Hotel; rapids between Mud Geyser and Lake.	16	14 4	Log	Good; needs hand rails; built 1891.
Over Antelope Creek, between Mud Geyser and canyon.	16	14 4	One span; sawed timber	Good; built 1891.
Over Trout Creek, between Mud Geyser and canyon.	16	14 4	......do	Do.
Over Sulphur Creek, about 5 miles from canyon toward Lake Hotel.	64	14 4	Trestle; sawed timber	Do.
Over Alum Creek, about 4½ miles from canyon toward lake.	80	14 4	Trestle; hewed timber, except floor.	Do.
Over small run along Yellowstone River, about 3 miles from canyon toward lake.	16	14 4	One span; sawed timber	Do.
Over dry run, about 2½ miles from canyon toward lake.	32	14 4	Two span	Do.
Over small creek, about 2¼ miles from canyon toward lake.	112	14 4	Trestle	Do.
Over Otter Creek, about 2 miles from canyon toward lake.	112	14 4	Low trestle	Do.
Over small creek and ravine at fork of road to Norris and lake, about 1 mile from canyon Hotel.	96	14 4	Trestle, about 40 feet high	Good.
Over small creek, about 1½ miles from Canyon Hotel on new road by Upper Falls.	16	14 4	One span	Good; needs hand rails; built 1892.
Over Crystal Falls, about ¾ mile from Canyon Hotel.	77	14 4	Queen truss, 45 feet	Good.
Over Gibbon River, about ½ mile above Virginia Cascade.	16	14 4	One span; log abutments	Do.
Over Gibbon River, about ½ mile from Norris toward canyon.	20	14 4	......do	Fair.
Over outlet of Bridge Creek, about 16½ miles from West Thumb toward Lake Hotel.	16	14 4	One span; sawed timber abutments.	Good.

In connection with these bridges I will state that there are a great number of culverts, from 2 to 6 feet in length, that do not appear in my report, as you had instructed me to report on bridges. I made no note of these culverts in regard to location. There are but a few which need repairing, and I am having that done as fast as we can get to them. I would have reported on these culverts had I not been pushed for time, but if you wish report on them I will look them up.

Respectfully submitted.

CHAS. A. HUNT,
U. S. Overseer.

Maj. W. A. JONES,
Corps of Engineers, U. S. A., St. Paul, Minn.

APPENDIX F F F.

EXPLORATIONS AND SURVEYS IN MILITARY DEPARTMENTS.

F F F 1.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE MISSOURI.

ANNUAL REPORT OF CAPT. WILLIAM L. MARSHALL, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

ENGINEER OFFICE,
HEADQUARTERS DEPARTMENT OF THE MISSOURI,
Chicago, Ill., July 18, 1894.

SIR: I have the honor to submit the following report as engineer officer of this department for the year ending June 30, 1894:

Previous to August 26, 1893, the office was in charge of First Lieut. Cassius E. Gillette, Corps of Engineers, and on the same day I was assigned to duty in accordance with paragraph 8, Special Orders No. 190, dated headquarters of the Army, A. G. O., Washington, D. C., August 19, 1893.

No field work has been done during the year.

The office force has consisted of one general service clerk, Frederick A. Petersen.

The office work has consisted in the preparation of maps, tracings, reproductions, etc., for the use of the department commander and other officers connected with the headquarters.

During the year there have been prepared 14 original drawings and tracings, issued 11 maps, and 3 maps mounted and corrected to date.

In April of this year an order was issued from headquarters of the Army to have contour maps made of the posts of Forts Leavenworth, Mackinac, Sill, Supply, and Wayne, under the direction of the engineer officer of the department. In a letter of April 10, 1894, to the adjutant-general at these headquarters, I recommended that the following officers be instructed to make the necessary surveys and maps under my direction: Second Lieut. James A. Ryan, Tenth Cavalry, for Fort Leavenworth; First Lieut. Woodbridge Geary, Nineteenth Infantry, for Fort Mackinac; Second Lieut. John H. Parker, Thirteenth Infantry, for Fort Sill; Second Lieut. H. L. Threlkeld, Thirteenth Infantry, for Fort Supply; and Second Lieut. Truman O. Murphy, Nineteenth Infantry, for Fort Wayne.

First Lieut. W. Geary, Nineteenth Infantry, and Second Lieut. T. O. Murphy, Nineteenth Infantry, have reported to me, and I have furnished them with the necessary instruments and instructions for doing the field work at their respective posts.

Second Lieut. John H. Parker, Thirteenth Infantry, having previously been directed by the commanding officer of Fort Sill to make a contour map of that post, has prepared one which will answer the purpose, when some corrections of the contour lines have been made in the western part of the map.

Second Lieut. F. H. Sargent, Seventh Infantry, was detailed to make the map of Fort Leavenworth, and reports on the 29th ultimo that about half the field work is finished.

Second Lieut. H. L. Threlkeld, Thirteenth Infantry, reports that he finished the map of Fort Supply on the 29th ultimo. On the 2d instant the map was sent to the chief quartermaster of the department, from whose office it was forwarded to the Quartermaster-General of the Army without reaching this office for examination.

Very respectfully, your obedient servant,

W. L. Marshall,
Captain, Corps of Engineers,
Engineer Officer Department of the Missouri.

Brig. Gen. Thomas L. Casey,
Chief of Engineers, U. S. A.

F F F 2.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE COLUMBIA.

REPORT OF MAJ. TULLY M'CREA, FIFTH UNITED STATES ARTILLERY, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

Engineer Office,
Headquarters Department of the Columbia,
Vancouver Barracks, Wash., July 12, 1894.

Sir: I have the honor to submit the following report of operations of the engineer office, Headquarters Department of the Columbia, for the fiscal year ending June 30, 1894.

FIELD WORK.

Survey and levels for a system of sewers for the sanitary drainage of the officers' quarters at the Vancouver barracks supply depot.

Survey and levels for the surface drainage of the low ground on the southeast portion of the Vancouver Barracks Military Reservation subject to overflow from high water in the Columbia River.

Survey and levels for the improvement of the grade of the skirmish range at Vancouver barracks and the supervision of above work for completion of the same.

Survey of the roads used by the public through and adjacent to the Vancouver Barracks Military Reservation.

At Forts Townsend, Sherman, Walla Walla, and Spokane surveys are being made to obtain the data necessary for the preparation of contour maps for the use of the Quartermaster-General of the Army.

OFFICE WORK.

The office work has consisted in the preparation of maps, plans, tracings, and blue prints for the use of the staff officers at these headquarters, the posts in the department, and troops in the field; the

revision of the department map, and the collection of information in regard to the Indian and military reservations in the department.

General service clerk Charles A. Homan was sent to Olympia and Seattle, Wash., for the purpose of consulting the land office records there and to determine and report what portions of each of the military reservations in the Puget Sound country are covered by adverse title or possession. He also obtained considerable information from the office of the surveyor-general at Olympia in regard to the progress of recent surveys in the State of Washington.

During the year there have been prepared 11 original maps and plans, 13 tracings, 35 solar prints, 45 reservation and township plats, 412 maps mounted on linen, and 155 maps of the department issued.

In addition to the above, many reports on different subjects have been made to the department commander and other miscellaneous work done.

Very respectfully, your obedient servant,

TULLY MCCREA,
Major, Fifth Artillery, Acting Engineer Officer.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

F F F 3.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF CALIFORNIA.

ANNUAL REPORT OF LIEUT. CHARLES G. LYMAN, SECOND CAVALRY, A. D. C., FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

ENGINEER OFFICE,
HEADQUARTERS DEPARTMENT OF CALIFORNIA,
San Francisco, Cal., July 26, 1894.

SIR: I have the honor to submit herewith the following report of operations for the fiscal year ending June 30, 1894:

Since rendering my report for the last fiscal year I have been in charge of this office, and C. Winstanley, general-service clerk, has been continuously on duty as topographer and draftsman.

The office work has involved the preparation of original drawings; tracing and blue-printing of maps, etc., for the use of these headquarters and of posts in the department; the distribution of maps, and the care and preservation of the surveying instruments in store.

Maps have been prepared and mounted to supply the different offices at these headquarters and at the depot in this city.

Instruments have been furnished to the different posts, to troops in the field, and to the quartermaster's department when required.

No field work of any importance, with the exception of the survey of a road on the Presidio Reservation for the depot quartermaster, has been entered into during the year.

Very respectfully, your obedient servant,

CHAS. G. LYMAN,
Second Lieut., Second Cavalry, A. D. C., in Charge of Office.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

LAWS

AFFECTING

THE CORPS OF ENGINEERS,

UNITED STATES ARMY

FIFTY-THIRD CONGRESS, SECOND SESSION.

1893-'94.

LAWS

AFFECTING

THE CORPS OF ENGINEERS, UNITED STATES ARMY.

FIFTY-THIRD CONGRESS, SECOND SESSION, 1893–'94.

PUBLIC ACTS.

CHAP. 12.—An Act To amend an Act of Congress approved May twelfth, eighteen hundred and ninety, granting to the Aransas Pass Harbor Company the right to improve Aransas Pass.

January 22, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Aransas Pass Harbor Company, which is engaged in the improvement of Aransas Pass under the provisions contained in an Act of Congress entitled "An Act for the improvement of Aransas Pass," approved May twelfth, eighteen hundred and ninety, is hereby relieved from the conditions of said Act which require the construction of said work to be commenced within one year from the date of its approval and to be diligently prosecuted by the expenditure of at least three hundred thousand dollars per annum thereafter, and to secure a navigable depth over the outer bar of fifteen feet of water within three years after the date of approval of said Act, and of twenty feet within five years from said date; and the said company is hereby authorized to continue and complete its work of improvement as set forth in said Act: *Provided,* That work shall be resumed by the said Aransas Pass Harbor Company within six months from the date of approval of this act, and shall be diligently prosecuted to completion, and said company shall secure a navigable depth over the outer bar of at least twenty feet of water within two years from the date of approval of this act. And in the event of said company failing to resume said work within the said six months, or failing to diligently prosecute the same, or to secure a navigable depth of twenty feet of water over the outer bar within the time required by this act, then Congress may revoke the privileges herein granted in relation to said improvement.

Aransas Pass Harbor. Time for constructing work extended.

Vol. 26, p. 108.

Proviso. Resumption of work.

Revocation on failure.

SEC. 2. That the right of Congress to alter, amend, or repeal this act is hereby reserved.

Amendment, etc.

Approved, January 22, 1894.

January 22, 1894.

CHAP. 15.—An Act To authorize the construction and maintenance of a dam or dams across the Kansas River, within Shawnee County, in the State of Kansas.

Kansas River. Dam across, authorized in Shawnee County.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Chicago-Topeka Light, Heat, and Power Company, a corporation organized under the laws of the State of Illinois, its successors and assigns, be, and they are hereby, authorized and empowered to construct and maintain a dam or dams across the Kansas River, at any suitable place or places within the county of Shawnee, in the State of Kansas: *Provided,* That on notice by the Secretary of War that said dam or dams are material obstructions to navigation, said dam or dams shall be at once removed, or suitable lock or locks provided by the owner or owners thereof at his or their expense, so as not to interfere with navigation: *And provided further,* That if after due and sufficient notice in such case the owner or owners of said dam or dams shall neglect or fail to provide suitable lock or locks, or otherwise modify or remove said obstructions, in such manner as the Secretary of War may direct, the said Secretary is hereby authorized and directed to cause suitable lock or locks to be provided, or said obstructions to be removed or modified at the expense of the United States, and to institute proceedings against the person or persons or corporation owning or controlling said dam or dams for the recovery of the expense thereof before the circuit court of the United States in and for the district in which said dam or dams may be located.

Proviso. Removal, etc.

Removal, etc., by Secretary of War.

Recovery of expense.

Commencement and completion.

SEC. 2. That the dam or dams herein provided for shall be commenced within one year from the date of approval of this act and completed within three years, under penalty of the forfeiture of the franchise herein granted.

Amendment, etc.

SEC. 3. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, January 22, 1894.

January 22, 1894.

CHAP. 18.—An Act To amend an Act approved September fourth, eighteen hundred and ninety, authorizing the New Orleans, Natchez and Fort Scott Railroad Company to construct two bridges across Boeuf River, in Louisiana.

Boeuf River, La. Time for bridging extended.

Vol. 26, p. 423.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Act approved September fourth, eighteen hundred and ninety, entitled "An Act to authorize the construction of two bridges across Boeuf River, Louisiana," be, and is hereby, amended so that the time within which the actual construction of said bridges may be commenced is hereby extended for the period of one year from the date of the approval of this Act.

Approved, January 22, 1894.

CHAP. 19.—An Act To authorize the Chattanooga Western Railway Company to construct a bridge across the Tennessee River near Chattanooga. January 27, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Chattanooga Western Railway Company, a corporation created and organized under the laws of the State of Tennessee, be, and is hereby, authorized to construct and maintain a bridge, and approaches thereto, over the Tennessee River, at or near the city of Chattanooga, in the county of Hamilton, State of Tennessee, which shall be so constructed as to provide for the passage of railway trains, locomotives, passenger and freight cars on, over, and across the same. And the right is also hereby given to the said county of Hamilton to erect, or cause to be erected, on, over, and above said railway bridge, using the latter as its substructure, a public bridge to be used for the passage of street cars, wagons, and vehicles of all kinds, and for animals and foot passengers.

Chattanooga Western Railway Company may bridge Tennessee River, Chattanooga, Tenn.

Railway bridge.

County may build wagon and foot bridge.

SEC. 2. That any bridge built under this act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post route, and shall enjoy the rights and privileges of other post-roads in the United States. That no higher charge shall be made for the transmission over the same of the mail, troops, and munitions of war of the United States, or for through railway passengers or freight passing over said bridge, than the rate per mile for their transmission over the railroads leading to said bridge, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies, and the United States shall have the right of way across said bridge for postal-telegraph purposes; that the said bridge shall be constructed either by draw, span, or otherwise, so that a free and unobstructed passageway may be secured to all water craft navigating said river at the point aforesaid: *Provided,* That if said bridge authorized to be constructed under this act shall be constructed as a drawbridge the draw shall be opened promptly upon reasonable signals for the passage of boats or vessels; and whatever kind of bridge is constructed said corporation shall maintain, at its own expense, from sunset to sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe.

Lawful structure and post route.

Charges.

Postal telegraph.

Unobstructed navigation.

Proviso.

Opening draw.

Lights, etc.

SEC. 3. That all railroad companies desiring the use of said bridge shall have, and be entitled to, equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon such basis or arrangement as may be agreed upon by and between such companies and the Chattanooga Western Railway Company; and in case the owner or owners of said bridge, and the several railroad companies, or any one of them, desiring such use, shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War

Use by other companies.

Disagreements.

Decision by Secretary of War.

upon the hearing of the allegations and proofs of the parties.

Secretary of War to approve plans, etc.

SEC. 4. That any bridge authorized to be constructed under this act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe. And to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for the space of one mile below and one mile above the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the current at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject, and until the said plan and location of the bridge are approved by the Secretary of War, the bridge shall not be built; and should any change be made in the plan of said bridge during the progress of construction, so as to prevent or remove all substantial obstruction to the navigation of said river, such change shall be subject to the approval of the Secretary of War; and if any litigation shall be had in regard to the location or construction of said bridge, the same shall be in the circuit court of the United States in whose territorial jurisdiction said bridge, or any part thereof, is located.

Changes.

Litigation.

Amendment, etc.

SEC. 5. That the right to alter, amend, or repeal this act is hereby expressly reserved; and any alterations or changes that may be required by Congress in the bridge constructed under this act, or its entire removal, shall be made by the corporation owning or controlling the same, at its own expense. Furthermore, if the construction of said bridge shall not be commenced within one and completed within three years after the passage of this act, all privileges conferred hereby and this act shall become null and void.

Commencement and completion.

Approved, January 27, 1894.

January 27, 1894.

CHAP. 22.—An Act To amend section thirty-seven hundred and nine of the Revised Statutes, relating to contracts for supplies in the Departments at Washington.

Supplies for Executive Departments.

R. S., sec. 3709, p. 733, amended.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section thirty-seven hundred and nine of the Revised Statutes is amended by adding thereto the following:

Advertisements for all the Departments to be on the same day.

And the advertisement for such proposals shall be made by all the Executive Departments, including the Department of Labor, the United States Fish Commission, the Interstate Commerce Commission, the Smithsonian Institution, the Government Printing Office, the government of the District of Columbia, and the superintendent of the

State, War, and Navy building, except for paper and materials for use of the Government Printing Office, and materials used in the work of the Bureau of Engraving and Printing, which shall continue to be advertised for and purchased as now provided by law, on the same days and shall each designate two o'clock post meridian of such days for the opening of all such proposals in each Department and other Government establishment in the city of Washington; and the Secretary of the Treasury shall designate the day or days in each year for the opening of such proposals and give due notice thereof to the other Departments and Government establishments. Such proposals shall be opened in the usual way and schedules thereof duly prepared and, together with the statement of the proposed action of each Department and Government establishment thereon, shall be submitted to a board, consisting of one of the Assistant Secretaries of the Treasury and Interior Departments and one of the Assistant Postmasters-General, who shall be designated by the heads of said Departments and the Postmaster-General respectively, at a meeting to be called by the official of the Treasury Department, who shall be chairman thereof, and said board shall carefully examine and compare all the proposals so submitted and recommend the acceptance or rejection of any or all of said proposals. And if any or all of such proposals shall be rejected, advertisements for proposals shall again be invited and proceeded with in the same manner.

Time for opening bids to be the same.

Submission to board for approval.

Readvertisement of rejected bids.

Approved, January 27, 1894.

CHAP. 24.—An Act Authorizing the Gulf, Beaumont and Kansas City Railway Company to bridge the Neches and Sabine rivers in the States of Texas and Louisiana.

February 2, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Gulf, Beaumont and Kansas City Railway Company, its successors or assigns, be, and is hereby, authorized to construct and maintain a railway bridge, and approaches thereto, over and across Neches River, in Texas; and also a railway bridge, and approaches thereto, over and across Sabine River, in Texas and Louisiana, at such points as may be selected by said railway company subject to approval by the Secretary of War for crossing said rivers with its railroad line. Said bridges shall be constructed to provide for the passage of railway trains and, if the Secretary of War shall at any time so determine, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, for foot passengers, for such reasonable rates of toll as may be approved from time to time by the Secretary of War. That if the said bridges, or either of them, over the said rivers shall be made with unbroken and continuous spans, there shall be at least one span of a height of not less than eighty feet above low water as understood

Gulf, Beaumont and Kansas City Railway Company may bridge Neches River, Tex., and Sabine River, Tex. and La.

Railway, wagon, and foot bridge.

Tolls.

Spans.

at the point of location, measured to the lowest part of the superstructure of said bridge; and said span shall have a clear opening of at least two hundred feet between the piers, measured at right angles to the current, and shall be over the main channel of the river, and the bridge or bridges shall be at right angles to and the piers parallel with the current of the river. And if the bridges, or either of them

Draw

over the said rivers shall be constructed as draw or pivot bridges the draw span shall be over the main channel of the river at accessible navigable points, and the openings on each side of the pivot pier shall not be less than one hundred feet in the clear unless otherwise expressly directed by the Secretary of War, and if so directed shall be according to such directions; and the said opening shall be acces

Height of spans.

sible at all stages of water, and the spans shall not be less than ten feet above extreme high water, as understood at the point of location, to the lowest part of the superstructure of the bridge, and the piers and draw rests shall be parallel with and the bridge or bridges at right angles to the current of the river or rivers; and no riprap or other outside protection for imperfect foundations shall be permitted to approach nearer than four feet to the surface of the water at its extreme low stage, or otherwise to encroach upon the channel ways provided for in this act; and all

Opening draw.

and each of said draws shall be opened promptly, upon reasonable signal, for the passing of boats; and said company shall maintain at its own expense from sunset till

Lights, etc.

sunrise, such lights or other signals on said bridges as the Light-House Board may prescribe.

Lawful structure and post route.

SEC. 2. That any bridge built under this act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge; and it shall enjoy the rights and privileges of other post roads in the United States.

Free navigation.

SEC. 3. That no bridge shall be erected or maintained under the authority of this Act which shall at any time substantially or materially obstruct the free navigation of said rivers, and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such

Changes.

navigation he is hereby authorized to cause such change or alteration of said bridge or bridges to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge. And in case of any

Litigation.

litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States for the eastern district of Texas, in whose jurisdiction any portion of said obstruc-

Proviso.

tion or bridge may be located: *Provided*, That nothing in this Act shall be so construed as to repeal or modify any of

Existing laws not affected.

the provisions of law now existing in reference to the pro-

tection of the navigation of rivers or to exempt said bridges from the operation of the same.

SEC. 4. That all railway companies desiring the use of said bridges, or either of them, shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use. Use by railway companies.

SEC. 5. That the bridges authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of navigation of said rivers as the Secretary of War shall prescribe; and to secure that object said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of said bridge, and each of them, and a map of the location, giving for the space of one mile above and one mile below the proposed location the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge or bridges are approved by the Secretary of War the bridge or bridges shall not be commenced or built; and should any change be made in the plan of said bridges, or either of them, during the progress of construction, such change shall be subject to the approval of the Secretary of War. And the said structure shall be changed at the cost and expense of the owners thereof from time to time, as the Secretary of War may direct, so as to preserve the free and convenient navigation of said rivers, and the authority to erect and continue any and all of said bridges shall be subject to revocation by the Secretary of War whenever the public good, in his judgment, so requires. Secretary of War to approve plans, etc. Changes.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved. Amendment, etc.

SEC. 7. That this Act shall be null and void if actual construction of the bridge or bridges herein authorized be not commenced within one year and completed within three years from the approval of this act. Commencement and completion.

Approved, February 2, 1894.

CHAP. 30.—An Act Granting to the Des Moines Rapids Power Company the right to erect, construct, operate, and maintain a wing dam, canal, and power station in the Mississippi River in Hancock County, Illinois. February 24, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the assent of Congress is hereby given to the Des Moines Rapids Power Company, a corporation created and organized under the laws of the State of Illinois, its successors and assigns, to erect, construct, operate, and maintain a Des Moines Rapids Power Company may build dam, etc., Mississippi River, Ill.

canal along the east bank of the Mississippi River, between Nauvoo and Hamilton, in Hancock County, in the State of Illinois, to erect, construct, operate, and maintain a power station thereon, and to project, erect, construct, operate, and maintain a wing dam five hundred feet into the river from the head of said canal, and to make such other improvements as may be necessary within said limit for the development of water power and the generation, use, and transmission therefrom of electric energy and power at, in, and upon the Des Moines Rapids of the Mississippi River:

Provisos. Navigation not obstructed.

Provided, That the constructions hereby authorized do not in any way interfere with the existing low-water channel over the Des Moines Rapids, or with any interests of navigation:

Secretary of War to approve plans, etc.

And provided further, That until the plans and locations of the works herein authorized, so far as they affect the interests of navigation, have been approved by the Secretary of War the canal shall not be commenced or built.

Commencement and completion.

SEC. 2. That this act shall be null and void if actual construction of the works herein authorized be not commenced within two years and completed within four years from the date hereof.

Amendment, etc.

SEC. 3. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Approved, February 24, 1894.

March 9, 1894.

CHAP. 33.—An Act To authorize the construction of a bridge over the Arkansas River at or near Van Buren, Arkansas.

Fort Smith and Van Buren Railway Company may bridge Arkansas River at Van Buren, Ark.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Fort Smith and Van Buren Railway Company, a corporation organized and existing under the laws of the State of Arkansas and being empowered by the terms of its charter to construct its railway from a point on the northern limits of the city of Fort Smith, Arkansas, to Van Buren, Arkansas, the construction and operation of said line of railway involving the construction of a bridge across the Arkansas River at a point at or near the city of Van Buren, be, and the said Fort Smith and Van Buren Railway Company, its successors and assigns, are hereby, authorized and empowered to construct said bridge across said river, and to maintain and operate the same as a railway, passenger, and wagon bridge.

Railway, wagon, and foot bridge.

Secretary of War to approve plans, etc.

SEC. 2. That any bridge authorized to be constructed under this Act, whether constructed as a high bridge or a drawbridge, shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object said company or corporation shall submit to the Secretary of War a design and drawing of said bridge to be erected for his examination and approval, and a map of its location, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until said plan and location

of said bridge are approved by the Secretary of War said bridge shall not be commenced or built; and should any change be made in the plan of any bridge authorized to be constructed by this Act during the progress of the work of construction, such change shall be subject to the approval of the Secretary of War: *Provided*, That if the bridge herein authorized be built as a drawbridge, the draw shall be opened promptly upon reasonable signal for the passage of boats; and whatever kind of bridge is built, the said company shall maintain thereon, from sunset to sunrise, such lights or other signals as the Light-House Board shall prescribe. That all railway companies desiring to use said bridge shall have and be entitled to equal rights and privileges in the passage of the same, and in the use of the machinery and fixtures thereof, and of all approaches thereto, under and upon such terms and conditions as shall be prescribed by the Secretary of War upon hearing the allegations and proofs of the parties, in case they shall not agree.

Changes.

Proviso.

Draw.

Lights, etc.

Use by other railway companies.

Terms.

SEC. 3. That any bridge built under this Act and subject to its limitations shall be a lawful structure and shall be recognized and known as a post route, upon which no higher charge shall be made for transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge; and it shall enjoy the rights and privileges of other post roads of the United States.

Lawful structure and post route.

SEC. 4. That the rates of toll which shall be charged for vehicles and foot passengers over said bridge shall be the same as those now established for like service by the laws of Arkansas as expressed in section five thousand five hundred and forty-six of Mansfield's Digest thereof, eighteen hundred and eighty-four, page ten hundred and sixty-eight.

Toll.

SEC. 5. That the right to alter, amend, or repeal this Act, or any part thereof, whenever Congress shall consider it necessary for the public interest, is hereby expressly reserved, and any expenditure required by reason of such legislation by Congress shall be made by the owners of said bridge or the corporation or parties controlling and using the same, without cost or damage to the United States.

Amendment, etc.

SEC. 6. That this act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date of approval of this Act.

Commencement and completion.

Approved, March 9, 1894.

March 12, 1894.

CHAP. 37.—An Act Making appropriations to supply further urgent deficiencies in the appropriations for the fiscal year ending June thirtieth, eighteen hundred and ninety-four, and for prior years, and for other purposes.

Urgent deficiencies appropriations.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, to supply deficiencies in the appropriations for the fiscal year eighteen hundred and ninety-four, and for other objects hereinafter stated, namely:

* * * * * * *

War Department.

WAR DEPARTMENT.

Repairs, old Ford's Theater.

For repairs to the old Ford's Theater building, in accordance with the recommendations of the board of engineer officers submitted to Congress in House Executive Document Numbered Sixty-one of this session, eleven thousand nine hundred and fifty-eight dollars.

* * * * * * *

Approved, March 12, 1894.

March 14, 1894.

CHAP. 41.—An Act To amend "An Act authorizing the construction of a bridge across the East River, between the city of New York and Long Island," approved March third, eighteen hundred and eighty-seven.

East River, N. Y.

Height of bridge may be reduced.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section three of an Act entitled "An Act authorizing the construction of a bridge across the East River, between the city of New York and Long Island," approved March third, eighteen hundred and eighty-seven, is hereby amended so as to read as follows:

Vol. 24, p. 469.

Construction.

SEC. 3. That such bridge shall be constructed at right angles with the channels of said river, the piers or abutments to be constructed on the land side of the harbor or pierhead lines established by law. The lowest part of the superstructure of such bridge, over the entire width of waterways, shall not be less than one hundred and thirty-five feet above mean high water of spring tides.

Height.

Approved, March 14, 1894.

March 24, 1894.

CHAP. 45.—An Act To amend an Act entitled "An Act authorizing the construction of a high wagon bridge at or near Sioux City, Iowa," approved March second, eighteen hundred and eighty-nine, as amended by acts of April thirtieth, eighteen hundred and ninety, and February seventh, eighteen hundred and ninety-three.

Bridge across Missouri River at Sioux City, Iowa.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section seven of an Act entitled "An Act authorizing the construction of a high wagon bridge across the Missouri

River at or near Sioux City, Iowa," approved March second, eighteen hundred and eighty-nine, as amended by an Act entitled "An Act to amend an Act entitled 'An Act authorizing the construction of a high wagon bridge across the Missouri River at or near Sioux City, Iowa,'" approved April thirtieth, eighteen hundred and ninety, and as amended by an Act entitled "An Act to amend an Act authorizing the construction of a high wagon bridge across the Missouri River at or near Sioux City, Iowa," approved February seventh, eighteen hundred and ninety-three, be amended so as to read as follows:

Vol. 25, p. 849; Vol. 26, p. 79; Vol. 27, p. 434.

"SEC. 7. That this Act shall be null and void if the construction of said bridge shall not be commenced within two years after the date of approving this Act and be finished on or before March second, eighteen hundred and ninety-six."

Time for construction extended.

Approved, March 24, 1894.

CHAP. 46.—An Act To amend an act entitled "An act to authorize the construction of a bridge across the Missouri River at the most accessible point between the city of Kansas and the town of Sibley, in the county of Jackson and State of Missouri," approved March third, eighteen hundred and eighty-seven.

March 29, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act entitled "An act to authorize the construction of a bridge across the Missouri River at the most accessible point between the city of Kansas and the town of Sibley, in the county of Jackson and State of Missouri," approved March third, eighteen hundred and eighty-seven, be, and the same hereby is, amended by striking out the following words contained in the first section of said act, to wit: "And free passage shall be accorded to wagons and vehicles of all kinds, and for the transit of animals and for foot passengers."

Bridge across Missouri River between Kansas City and Sibley, Mo.

Vol. 24, p. 493, amended.

Free passage repealed.

SEC. 2. That the word "corporations" in the first section of the act hereinbefore named shall be changed to "corporation."

Verbal correction.

SEC. 3. The construction of the bridge authorized to be constructed by the act approved March third, eighteen hundred and eighty seven, hereinbefore named, and of which this act is amendatory, shall begin within three years, and be completed within ten years from the date of the approving this act, and unless these conditions be complied with, this act and the act of which it is amendatory shall be null and void.

Time for construction extended.

Approved, March 29, 1894.

March 29, 1894.

CHAP. 47.—An Act For a charter for the Iowa and Nebraska Pontoon Bridge Company.

Iowa and Nebraska Pontoon Bridge Company may bridge Missouri River at Sioux City, Iowa.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Iowa and Nebraska Pontoon Bridge Company, a corporation duly organized and existing under and by virtue of the laws of the State of Iowa, its successors or assigns, be, and is hereby, authorized to construct, erect, and maintain a pontoon wagon and foot bridge across the Missouri River between Iowa and Nebraska in or near the corporate limits of Sioux City, in Woodbury County, and State of Iowa.

Toll.

SEC. 2. That the owners of said bridge may also have and receive a reasonable compensation or tolls for the transit over said bridge of all street cars, wagons, foot passengers, animals, and for all other uses of said bridge not specially enumerated: *Provided*, That the Secretary of War may at any time prescribe such rules, regulations, and rate of toll for transit and transportation over said bridge as may be deemed proper and reasonable.

Proviso. Regulations, etc.

Lawful structure and post route.

SEC. 3. That any bridge built under this Act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post route, upon which, also, no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroads or public highways leading to said bridge, and it shall enjoy the rights and privileges of other post roads in the United States; and an equal privilege in the use of said bridge shall be granted to all telegraph and telephone companies, and the United States shall have the right of way across said bridge and its approaches for postal-telegraph purposes.

Postal telegraph, etc.

Draw, etc.

SEC. 4. That said bridge shall be constructed with a suitable draw, giving not less than 400 feet clear channel way for each navigable channel of the river, and such other openings for the passage of rafts and logs as in the opinion of the Secretary of War may be necessary: *Provided*, That said draws shall be opened to the full width promptly upon reasonable signal to allow the passage of boats and all floating craft.

Proviso. Opening draw.

Secretary of War to approve plans, etc.

SEC. 5. That said bridge shall be built and located under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall prescribe; and to secure that object the said parties shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines at low and high water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such information as may be required for a full and satisfactory understanding of the subject; and

until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be commenced or built, and should any changes be made in the plan of said bridge during the progress of construction or after completion, such changes shall be subject to the approval of the Secretary of War; and the said bridge shall be constructed with such aids to the passage of said bridge, in the form of booms, dikes, piers, or other suitable and proper structures for confining the flow of water to a permanent and easily navigated channel for a distance of not less than one mile above the bridge location, and for the guiding of rafts, steamboats and other water craft safely through the draw and raft spans, as the Secretary of War shall prescribe and order to be constructed and maintained, at the expense of the company owning said bridge; and the said structure shall be at all times so kept and managed as to offer reasonable and proper means for the passage of vessels through said structure.

Changes.

Aids to navigation.

SEC. 6. That the said parties shall maintain at their own expense, from sunset till sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe.

Lights, etc.

SEC. 7. That the right to alter, amend, or repeal this Act, or any part thereof, at any time, by the Congress of the United States, is hereby expressly reserved; and any change in the construction or any alteration of said bridge that may be directed at any time by Congress or the Secretary of War shall be at the expense of the owners of said bridge or the parties operating and controlling the same.

Amendment, etc.

SEC. 8. That if actual construction of the bridge herein authorized shall not be commenced within one year and completed within two years from the date of the approval of this act the rights and privileges hereby granted shall cease and determine.

Commencement and completion

SEC. 9. All the rights granted by this act shall cease whenever the Secretary of War shall determine and give the notice hereinafter provided, that the high wagon bridge across the Missouri River at or near Sioux City, Iowa, authorized by an Act approved March the second, eighteen hundred and eighty-nine, and amended April the thirtieth, eighteen hundred and ninety, and February the seventh, eighteen hundred and ninety-three, is completed and open for travel. And it shall be the duty of the Secretary of War to give the owners of said pontoon bridge notice to remove the same within twelve months from the date of said notice, and if the company owning said bridge shall neglect to make such removal within said time, it shall then be his duty to cause the same to be removed at the expense of said company.

Rights to cease on opening other bridge.

Vol. 25, p. 849; Vol. 26, p. 79; Vol. 27, p. 434.

Notice of removal.

Approved, March 29, 1894.

March 29, 1894. **CHAP. 49.—An Act To regulate the making of property returns by officers of the Government.**

Property returns.

Only certificates of loss to be forwarded to Treasury accounting officers.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That instead of forwarding to the accounting officers of the Treasury Department returns of public property entrusted to the possession of officers or agents, the Quartermaster-General, the Commissary-General of Subsistence, the Surgeon-General, the Chief of Engineers, the Chief of Ordnance, the Chief Signal Officer, the Paymaster-General of the Navy, the Commissioner of Indian Affairs, or other like chief officers in any Department, by, through, or under whom stores, supplies, and other public property are received for distribution, or whose duty it is to receive or examine returns of such property, shall certify to the proper accounting officer of the Treasury Department, for debiting on the proper account, any charge against any officer or agent intrusted with public property, arising from any loss, accruing by his fault, to the Government as to the property so intrusted to him.

Contents of certificate.

SEC. 2. That said certificate shall set forth the condition of such officer's or agent's property returns, that it includes all charges made up to its date and not previously certified, that he has had a reasonable opportunity to be heard and has not been relieved of responsibility; the effect of such certificate, when received, shall be the same as if the facts therein set forth had been ascertained by the accounting officers of the Treasury Department in accounting.

Manner of returns, etc., not affected.

SEC. 3. That the manner of making property returns to or in any administrative bureau or department, or of ascertaining liability for property, under existing laws and regulations, shall not be affected by this Act, except as provided in section one; but in all cases arising as to such property so intrusted the officer or agent shall have an opportunity to relieve himself from liability.

Regulations.

SEC. 4. That the heads of the several Departments are hereby empowered to make and enforce regulations to carry out the provisions of this Act.

Repeal.

SEC. 5. That all laws or parts of laws inconsistent with the provisions of this Act are hereby repealed.

Approved, March 29, 1894.

April 2, 1894. **CHAP. 51.—An Act To authorize the construction of a bridge over the Monongahela River at Glenwood, Pennsylvania.**

Glenwood Highway Bridge Company may bridge Monongahela River, Pittsburg, Pa.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Glenwood Highway Bridge Company, a corporation duly organized under the laws of the Commonwealth of Pennsylvania, its successors and assigns, be, and they are hereby, authorized and empowered to construct, maintain, and operate a bridge over the Monongahela River, from a point on the north shore of said Monongahela River at or near where Second avenue in the Twenty-third ward of the city of Pittsburg is crossed by the Pittsburg and Con-

nellsville Railroad, to a point directly across said river, on the south shore thereof, about four hundred feet, more or less, below the mouth of Streets Run and above the foundation of the old coal tipple at Hays Station, all within the County of Allegheny and State of Pennsylvania. That said Glenwood Highway Bridge Company shall not commence the construction of its bridge, bridge piers, abutments, causeway, and other works over or in said Monongahela River until the location and plan of the same shall have been submitted to and approved by the Secretary of War.

Secretary of War to approve plans, etc.

SEC. 2. That any bridge authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of the bridge and a map of the location, giving for the space of one-half mile above and one-half mile below the proposed location the high and low water lines upon the banks of the river, the direction and strength of the currents at low and at high water, with the soundings accurately showing the bed of the stream, and the location of any other bridge or bridges, such map to be sufficiently in detail to enable the Secretary of War to judge of the proper location of said bridge, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be commenced or built; and should any change be made in the plans of said bridge during the progress of its construction, such changes shall be subject to the approval of the Secretary of War: *Provided*, That the channel span of said bridge shall be not less than five hundred feet in length in the clear and the clear height of the superstructure shall not be less than fifty-three feet above the level of the water at pool full in said river.

Proviso. Channel span.

Unobstructed navigation.

SEC. 3. That said bridge herein authorized to be constructed shall be so kept and managed at all times as to afford proper means and ways for the passage of vessels, barges, or rafts, both by day and by night, and there shall be displayed on said bridge by the owners thereof, from sunset to sunrise, such lights and other signals as the Light-House Board may prescribe; and such changes shall be made from time to time in the structure of said bridge as the Secretary of War may direct, at the expense of said bridge company, in order the more effectually to preserve the free navigation of said river.

Lights, etc.

Commencement and completion.

SEC. 4. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date of the approving this act.

Amendment, etc.

SEC. 5. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, April 2, 1894.

April 2, 1894.

CHAP. 52.—An Act Authorizing the Texarkana and Fort Smith Railway Company to bridge the Calcasieu and Sabine rivers in the States of Louisiana and Texas.

Texarkana and Fort Smith Railway Company may bridge Calcasieu River, La., and Sabine River, La. and Tex.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Texarkana and Fort Smith Railway Company, its successors or assigns, be, and is hereby, authorized to construct and maintain a railway bridge, and approaches thereto, over and across Calcasieu River in Louisiana; and also a railway bridge and approaches thereto, over and across Sabine River in Louisiana and Texas, at such points as may be selected by said railway company for crossing said rivers with its railroad line, said points selected to be subject to the approval of the Secretary of War. Said bridges shall be constructed to provide for the passage of railway trains, and, at the option of said company, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for such reasonable rates of toll as may be approved from time to time by the Secretary of War. That if the said bridges or either of them, over the said rivers shall be made with unbroken and continuous spans, there shall be at least one span of a height of not less than eighty feet above low water as understood at the point of location, measured to the lowest part of the superstructure of said bridge; and said span shall have a clear opening of at least two hundred feet between the piers, measured at right angles to the current, and shall be over the main channel of the river, and the bridge or bridges shall be at right angles to, and the piers parallel with, the current of the river. And if the bridges, or either of them, over the said rivers shall be constructed as draw or pivot bridges, the draw or pivot pier shall be over the main channel of the river at an accessible navigable point, and the openings on each side of the pivot pier shall not be less than one hundred feet in the clear, unless otherwise expressly directed by the Secretary of War, and if so directed shall be according to such direction, and the said openings shall be accessible at all stages of water, and the spans shall be not less than ten feet above extreme high water, as understood at the point of location, to the lowest part of the superstructure of the bridge, and the piers and draw rests shall be parallel with, and the bridge or bridges at right angles to, the current of the river or rivers; and no riprap or other outside protection for imperfect foundations shall be permitted to approach nearer than four feet to the surface of the water at its extreme low stage, or otherwise to encroach upon the channel ways provided for in this act; and all and each of said draws shall be opened promptly upon reasonable signal for the passing of boats; and whatever kind of bridges shall be constructed said company shall maintain, at its own expense, from sunset till sunrise, such lights or other signals on said bridges as the Light-House Board may prescribe.

Railway, wagon, and foot bridges.

Toll.

High bridges.

Draw bridges.

Opening draw.

Lights, etc.

Lawful structures and post routes.

SEC. 2. That any bridge built under this act, and subject to its limitations, shall be a lawful structure, and shall

be recognized and known as a post route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge; and it shall enjoy the rights and privileges of other post-roads in the United States.

Unobstructed navigation.

SEC. 3. That no bridge shall be erected or maintained under the authority of this Act which shall at any time substantially or materially obstruct the free navigation of said rivers; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of such bridge or bridges to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge. And in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States for the western district of Louisiana, in whose jurisdiction any portion of said obstruction or bridge may be located: *Provided*, That nothing in this Act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers or to exempt said bridges from the operation of the same.

Changes.

Litigation.

Proviso. Existing laws not affected.

Use by other companies.

SEC. 4. That all railway companies desiring the use of said bridges, or either of them, shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use.

Secretary of War to approve plans, etc.

SEC. 5. That the bridges authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of navigation of said rivers as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of said bridges, and each of them, and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge or bridges are approved by the Secretary of War the bridge or bridges shall not be built; and should any change be made in the plan of said bridges, or either of them, during the progress of construction, such change shall be subject to approval of the Secretary of War. And the said structures shall be changed at the cost and expense of the owners thereof, from time to time, as the Secretary of War may

Changes.

direct, so as to preserve the free and convenient navigation of said rivers, and the authority to erect and continue any and all of said bridges shall be subject to revocation by the Secretary of War whenever the public good, in his judgment, so requires.

Amendment, etc. SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Commencement and completion. SEC. 7. That this Act shall be null and void if actual construction of the bridge or bridges herein authorized be not commenced within one year and completed within three years from the approval of this Act.

Approved, April 2, 1894.

April 5, 1894. CHAP. 56.—An Act Authorizing the Texarkana and Fort Smith Railway Company to bridge Caddo Lake at or near Mooringsport, Louisiana, and Cross Bayou, near Shreveport, Louisiana.

Texarkana and Fort Smith Railway Company may bridge Caddo Lake, Mooringsport, La., and Cross Bayou, Shreveport, La.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Texarkana and Fort Smith Railway Company, its successors or assigns, be, and is hereby, authorized to construct and maintain a railway bridge, and approaches thereto, over and across Caddo Lake, near Mooringsport, Louisiana, and also a railway bridge, and approaches thereto, over and across Cross Bayou, near Shreveport, Louisiana, at such point as may be selected by said railway company for crossing said bayou with its railroad line. Said bridges shall be constructed to provide for the passage of railway trains, and, at the option of said company, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for such reasonable rates of toll as may be approved from time to time by the Secretary of War. That the bridges over the said streams shall be constructed as draw or pivot bridges, the draw or pivot pier shall be over the main channel of the stream at an accessible navigable point, and the openings on each side of the pivot pier shall not be less than one hundred feet in the clear, unless otherwise expressly directed by the Secretary of War, and if so directed shall be according to such direction, and the said openings shall be accessible at all stages of water, and the spans shall be not less than ten feet above extreme high water, as understood at the point of location, to the lowest part of the superstructure of the bridge, and the piers and draw rests shall be parallel with, and the bridge or bridges at right angles to, the current of the stream or streams, and no riprap or other outside protection for imperfect foundations shall be permitted to approach nearer than four feet to the surface of the water at its extreme low stage, or otherwise to encroach upon the channel ways provided for in this Act; and all and each of said draws shall be opened promptly upon reasonable signals for the passage of boats; and said company shall maintain, at its own expense, from sunset till sunrise, throughout the season of navigation,

Railway, wagon, and foot bridges.

Toll.

Draw bridges.

Opening draws.

such lights or other signals on said bridges as the Light-House Board may prescribe. Lights, etc.

SEC. 2. That any bridge built under this Act, and subject to its limitations, shall be a lawful structure, and shall be recognized and known as a post-route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge; and it shall enjoy the rights and privileges of other post-roads in the United States. Lawful structures and post routes.

SEC. 3. That no bridge shall be erected or maintained under the authority of this Act which shall at any time substantially or materially obstruct the free navigation of said streams; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge or bridges to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge. And in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said streams, caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States for the western district of Louisiana: *Provided*, That nothing in this Act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers or to exempt said bridges from the operation of the same. Unobstructed navigation. Litigation. *Proviso.* Existing laws not affected.

SEC. 4. That all railway companies desiring the use of said bridges, or either of them, shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use. Use by other companies.

SEC. 5. That the bridges authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of navigation of said streams as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of said bridges, and each of them, and a map of the location, giving, for the space of one-half mile above and one-half mile below the proposed location, the topography of the banks of the streams, the shore lines at high and low water, the direction and strength of the currents at all stages, and the soundings accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge or bridges are approved by the Secretary of War the bridge or bridges shall not be built; and should any change be made in the plan of said bridges, or either of them, during the progress of construction, such change Secretary of War to approve plans, etc. Changes.

shall be subject to approval of the Secretary of War. And the said structure shall be changed at the cost and expense of the owners thereof, from time to time, as the Secretary of War may direct, so as to preserve the free and convenient navigation of said streams, and the authority to erect and continue any and all of said bridges shall be subject to revocation by the Secretary of War whenever the public good, in his judgment, so requires.

Amendment, etc.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Commencement and completion.

SEC. 7. That this act shall be null and void if actual construction of the bridge or bridges herein authorized be not commenced within one year and completed within three years from the approval of this Act.

Approved, April 5, 1894.

April 21, 1894.

CHAP. 58.—An Act Authorizing the Texarkana and Fort Smith Railway Company to bridge the Sulphur River in the State of Arkansas or in the State of Texas.

Texarkana and Fort Smith Railway Company may bridge Sulphur River, Ark. or Tex.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Texarkana and Fort Smith Railway Company, its successors or assigns, be, and is hereby, authorized to construct and maintain a railway bridge, and approaches thereto, over and across Sulphur River in the State of Arkansas, or in the State of Texas, at such point as may be selected by said railway company for crossing said river with its railroad line, said point selected to be subject to the approval of the Secretary of War. Said bridge shall be constructed to provide for the passage of railway trains, and, at the option of said company, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for such reasonable rates of toll as may be approved from time to time by the Secretary of War. That if the said bridge shall be made with unbroken and continuous spans, there shall be at least one span of a height of not less than eighty feet above low water, or fifty feet above highest water, as understood at the point of location, measured to the lowest part of the superstructure of said bridge; and said span shall have a clear opening of at least one hundred and fifty feet between the piers, measured at right angles to the current, and shall be over the main channel of the river; and the bridge shall be at right angles to, and the piers parallel with, the current of the river. And if the bridge over the said river shall be constructed as a draw or pivot bridge, the draw or pivot pier shall be over the main channel of the river at an accessible navigable point, and the openings on each side of the pivot pier shall not be less than one hundred feet in the clear, unless otherwise expressly directed by the Secretary of War, and if so directed shall be according to such direction, and the said opening shall be accessible at all stages of

Railway, wagon, and foot bridge.

Toll.

High bridge.

Drawbridge.

water, and the spans shall be not less than ten feet above extreme high water, as understood at the point of location, to the lowest part of the superstructure of the bridge, and the piers and draw rests shall be parallel with, and the bridge at right angles to, the current of the river; and no riprap or other outside protection for imperfect foundations shall be permitted to approach nearer than four feet to the surface of the water at its extreme low stage, or otherwise to encroach upon the channel ways provided for in this Act; and the draw shall be opened promptly upon reasonable signal for the passing of boats; and whatever kind of bridge shall be constructed said company shall maintain, at its own expense, from sunset till sunrise, throughout the season of navigation, such lights or other signals on said bridge as the Light-House Board may prescribe.

Opening draw.

Lights, etc.

SEC. 2. That the bridge built under this Act, and subject to its limitations, shall be a lawful structure, and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge; and it shall enjoy the rights and privileges of other post roads in the United States.

Lawful structure and post route.

SEC. 3. That no bridge shall be erected or maintained under the authority of this Act which shall at any time substantially or materially obstruct the free navigation of said river; and if the bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge. And in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States for the State of Arkansas, in whose jurisdiction any portion of said obstruction or bridge may be located: *Provided*, That nothing in this Act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers or to exempt said bridge from the operation of the same.

Unobstructed navigation.

Litigation.

Proviso.

Existing laws not affected.

SEC. 4. That all railway companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use.

Use by other companies.

SEC. 5. That the bridge authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval,

Secretary of War to approve plans, etc.

a design and drawings of said bridge and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of said bridge during the progress of construction, such change shall be subject to the approval of the Secretary of War. And the said structure shall be changed at the cost and expense of the owners thereof, from time to time, as the Secretary of War may direct, so as to preserve the free and convenient navigation of said river, and the authority to erect and continue said bridge shall be subject to revocation by the Secretary of War whenever the public good, in his judgment, so requires.

Changes.

Amendment, etc.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Commencement and completion.

SEC. 7. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the approval of this Act.

Approved, April 21, 1894.

April 21, 1894.

CHAP. 59.—An Act To extend the time authorizing the Saint Louis and Birmingham Railroad to build a bridge across Tennessee River at Clifton, Tennessee.

Bridge across Tennessee River at Clifton, Tenn.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Saint Louis and Birmingham Railway Company, being a corporation created and organized under the laws of the State of Tennessee, and to which authority was given by an Act of Congress entitled "An Act to authorize building a bridge over Tennessee River," approved June sixth, eighteen hundred and ninety-two, is hereby given the right to begin the construction of the bridge therein authorized according to the terms of said Act within twelve months from the approval of this Act, the said bridge to be completed within three years from said date. It is hereby further provided that if the construction of said bridge be not commenced and the structure completed within the times hereinbefore mentioned, then this Act, and that approved June sixth, eighteen hundred and ninety-two, to which reference is hereinbefore made, shall be null and void.

Vol. 27, p. 47.

Time for construction extended.

Amendment, etc.

SEC. 2. That the right to alter, amend, or repeal this Act is hereby expressly reserved without any liability on the part of the United States for any damages on account of such alteration, amendment, or repeal.

Approved, April 21, 1894.

CHAP. 60.—An Act To authorize the West Braddock Bridge Company to construct a bridge over the Monongahela River from the borough of Rankin to Mifflin Township.

April 21, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be lawful for the West Braddock Bridge Company, a corporation organized under the laws of the Commonwealth of Pennsylvania, to construct and maintain a bridge and approaches thereto over the Monongahela River from a point in the borough of Rankin, in the county of Allegheny, to a point in Mifflin Township, in the county of Allegheny.

West Braddock Bridge Company may bridge Monongahela River, Allegheny County, Pa.

SEC. 2. That said bridge may be constructed to provide for the passage of railway trains, street cars, wagons, and vehicles of all kinds, for the transit of animals, foot passengers, and all kinds of commerce, travel, or communication, and said corporation may charge and receive reasonable tolls therefor, subject to the approval of the Secretary of War.

Railway, wagon, and foot bridge.

SEC. 3. That any bridge built under this Act and subject to its limitations, shall be a lawful structure, and shall be recognized and known as a post-route, and it shall enjoy the rights and privileges of other post-roads in the United States: *Provided*, That the United States may construct a postal telegraph over said bridge without charge therefor.

Lawful structure and post route.

Proviso. Postal telegraph.

SEC. 4. That said bridge shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to this end the said corporation shall submit to the Secretary of War for his examination and approval the plans and drawings of said bridge, and a map of the proposed location, giving, for the space of one mile each way, the topography of the banks of the river and the shore lines at high and low water, the direction and strength of the current at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges in the vicinity, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject, and until the plan and location of said bridge have been approved by the Secretary of War, the bridge shall not be commenced or built: *Provided*, That the channel span of said bridge shall be in length not less than four hundred feet in the clear.

Secretary of War to approve plans, etc.

Proviso. Channel span.

SEC. 5. That all railroad companies desiring the use of any bridge constructed under this Act shall have and be entitled to equal rights and privileges relative to the passage of railway trains or cars over the same and the approaches thereto, upon payment of reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any of them desiring such use, shall fail to agree upon the sum or sums to be paid and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proof of the parties.

Use by railroad companies.

Compensation.

Unobstructed navigation.

SEC. 6. That said bridge herein authorized to be constructed shall be so kept and managed at all times as to afford proper means and ways for the passage ot vessels, barges, or rafts both by day and by night, and there shall be displayed on said bridge by the owners thereof, from sunset to sunrise, such lights or other signals as the Light-House Board may prescribe; and such changes shall be made from time to time in the structure of said bridge as Congress may direct, at the expense of said bridge company, in order the more effectually to preserve the free navigation of said river.

Lights, etc.

Changes.

Amendment, etc.

SEC. 7. That the right to alter, amend, or repeal this Act is hereby expressly reserved, and the right to require any changes in said structure or its entire removal at the expense of the owners thereof, or the corporation of persons controlling the same, whenever public interests require it, is also reserved.

Commencement and completion.

SEC. 8. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date of the approval of this Act.

Approved, April 21, 1894.

April 21, 1894.

CHAP. 61.—An Act To provide for further urgent deficiencies in the appropriations for the service of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-four, and for other purposes.

Urgent deficiencies appropriations.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums, or so much thereof as may be necessary, be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, for the objects hereinafter expressed, being for the service of the fiscal year eighteen hundred and ninety-four, namely:

* * * * * * *

War Department.

WAR DEPARTMENT.

Repairs, Ford's Theater.

Appropriation continued.

That the appropriation of eleven thousand nine hundred and fifty-eight dollars, made for the repair of the old Ford's Theater building by the Act approved March twelfth, eighteen hundred and ninety-four, is made available for expenditure during the fiscal year eighteen hundred and ninety-five.

New York Harbor.

HARBOR OF NEW YORK: For prevention of obstructive and injurious deposits within the harbor and adjacent waters of New York City:

Steamer "Nimrod."

For pay of crew and maintenance of steamer Nimrod, two thousand dollars.

* * * * * * *

Approved, April 21, 1894.

CHAP. 62.—An Act Authorizing the Texarkana and Fort Smith Railway Company to bridge Little River, in the State of Arkansas.

April 21, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Texarkana and Fort Smith Railway Company, its successors or assigns, be, and is hereby, authorized to construct and maintain a railway bridge, and approaches thereto, over and across Little River, in the State of Arkansas, at or near Morris Ferry. Said bridge shall be constructed to provide for the passage of railway trains, and, at the option of said company, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers for such reasonable rates of toll as may be approved from time to time by the Secretary of War. That if the said bridge shall be made with unbroken and continuous spans there shall be at least one span of a height of not less than fifty feet above low water as understood at the point of location, measured to the lowest part of the superstructure of said bridge; and said span shall have a clear opening of at least two hundred and fifty feet between the piers, measured at right angles to the current, and shall be over the main channel of the river, and the bridge shall be at right angles to, and the piers parallel with, the current of the river. And if the bridge over the said river shall be constructed as a draw or pivot bridge the draw or pivot pier shall be over the main channel of the river at an accessible navigable point, and the openings on each side of the pivot pier shall not be less than one hundred and thirty feet in the clear, unless otherwise expressly directed by the Secretary of War, and, if so directed, shall be according to such direction, and the said openings shall be accessible at all stages of water, and the spans shall be not less than ten feet above extreme high water, as understood at the point of location, to the lowest part of the superstructure of the bridge, and the piers and draw rests shall be parallel with and the bridge at right angles to the current of the river; and no riprap or other outside protection for imperfect foundations shall be permitted to approach nearer than four feet to the surface of the water, at its extreme low stage, or otherwise to encroach upon the channelways provided for in this Act; and the draw shall be opened promptly upon reasonable signal for the passing of boats; and whatever kind of bridge shall be constructed said company shall maintain, at its own expense, from sunset till sunrise throughout the season of navigation, such lights or other signals on said bridge as the Light-House Board may prescribe.

Texarkana and Fort Smith Railway Company may bridge Little River at Morris Ferry, Ark.

Railway, wagon, and foot bridge.

High bridge.

Draw bridge.

Opening draw.

Lights, etc.

SEC. 2. That the bridge built under this Act, and subject to its limitations, shall be a lawful structure, and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to

Lawful structure and post route.

the said bridge; and it shall enjoy the rights and privileges of other post-roads in the United States.

Unobstructed navigation.

SEC. 3. That no bridge shall be erected or maintained under the authority of this Act which shall at any time substantially or materially obstruct the free navigation of said river; and if the bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge. And in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States for the State of Arkansas, in whose jurisdiction any portion of said obstruction or bridge may be located: *Provided*, That nothing in this Act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers or to exempt said bridge from the operation of the same.

Litigation.

Proviso.

Existing laws not affected.

Use by other companies.

SEC. 4. That all railway companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use.

Secretary of War to approve plans, etc.

SEC. 5. That the bridge authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of said bridge and a map of the location, giving for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject: and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built: and should any change be made in the plan of such bridge during the progress of construction, such change shall be subject to the approval of the Secretary of War. And the said structure shall be changed at the cost and expense of the owners thereof, from time to time as the Secretary of War may direct, so as to preserve the free and convenient navigation of said river, and the authority to erect and continue said bridge shall be subject to revocation by the Secretary of War, whenever the public good, in his judgment, so requires.

Changes.

Amendment, etc.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

SEC. 7. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the approval of this Act. Commencement and completion.

Approved, April 21, 1894.

CHAP. 64.—An Act To authorize the construction of a steel bridge over the Saint Louis River, between the States of Wisconsin and Minnesota. April 24, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Duluth and Superior Bridge Company, a corporation organized under the laws of the State of Wisconsin, and its successors in interest be, and is hereby, authorized to construct and maintain and operate a bridge and approaches thereto over the Saint Louis River, between the States of Wisconsin and Minnesota, extending from the northerly end of Conners Point, Wisconsin, to Rices Point, opposite, in the State of Minnesota. Said bridge shall be constructed to provide for the passage of street railway cars, steam cars, on double tracks permitting the passage of trains in opposite directions at the same time, and for the passage of wagons and vehicles of all kinds, and for the transit of animals, and for foot passengers, under such reasonable rules and regulations as may be prescribed by said company or its successors in interest, and for such reasonable rates of toll as may be agreed upon by the parties in interest and approved by the Secretary of War: *Provided, however*, That the right of passage over said bridge and approaches shall at all times be free to the employees and apparatus of the fire and police departments of the cities of Duluth and Superior, when in actual service. And in case of any litigation concerning any alleged obstruction to the free navigation of said river on account of said bridge the cause shall be tried before the circuit court of the United States in whose jurisdiction any portion of said obstruction or bridge is located.

Duluth and Superior Bridge Company may bridge Saint Louis River, Conners Point, Wis., to Rices Point, Minn.

Railway, wagon, and foot bridge.

Toll.

Proviso.

Free passage.

Litigation.

SEC. 2. That any bridge built under the provisions of this Act shall be built and constructed without material interference with the security and convenience of navigation on said river beyond what is necessary to carry into effect the rights and privileges hereby granted, and shall be at least twenty-eight feet in height in the clear above high water mark, with rafting spans on either side of the draw of not less than two hundred and fifty feet each; and, in order to secure compliance with these conditions, the said corporation shall submit to the Secretary of War a plan of the bridge and accessory works provided for in this Act, together with a detailed map of the river for a distance of one mile above and one mile below the proposed site of said bridge, with such information as may be required by the Secretary of War for a full and satisfactory understanding of the subject; and the Secretary of War is hereby authorized and directed, upon receiving such plan and map

Unobstructed navigation.

Secretary of War to approve plans, etc.

and other information and being satisfied that the bridge built upon such plan and with such accessory works and at such locality will conform to the prescribed condition of this Act, to notify the company that he approved the same; and upon receiving such notification the said company may proceed to the erection of said bridge, conforming strictly to the approved plan and location; but until the Secretary of War shall approve the plan and location of said bridge and accessory works, and notify the company of the same, the bridge shall not be built or commenced; and should any change be made or become necessary in the plan of the bridge or accessory works during the progress of construction or after completion such change shall likewise be subject to the approval and direction of the Secretary of War: *Provided, however*, That if, in the opinion of the Secretary of War, the interests of navigation permit it, it shall be within his discretion to reduce the requirement of height in the clear above high-water mark from twenty-eight feet to twenty-six feet.

Changes.

Proviso.

Reduction of height.

Aids to navigation.

SEC. 3. That the accessory works referred to in the preceding section shall be such booms, dikes, piers, or other suitable and proper structures for confining the flow of water to a permanent channel, and for the guiding of steamboats, rafts, and other water craft safely through the draw and rafting spans, as shall be required by the Secretary of War; and in addition thereto, and before the construction of the bridge to be built under this Act, the company or persons owning or holding such bridge shall be required, under the direction of the Secretary of War or such officer as he shall designate, to dredge out to a minimum depth of twenty-one feet the two triangular spaces above and below the proposed site of the bridge included in the interior angles formed by the crossing of the two channels at "the gate," to such an extent as to create a basin, the easterly and westerly limits of which shall be, respectively, at not to exceed one thousand feet from the axis of the bridge, and such basin shall be maintained by the said company or persons owning and holding said bridge, at all times thereafter, in a condition affording safe navigation to all vessels drawing twenty feet of water.

Dredging required.

Draw.

SEC. 4. That the bridge built under this Act shall be constructed as a pivot drawbridge, with the draw over the main channel of the river at an accessible and navigable point, and with a span of not less than two hundred feet in length in the clear on each side of the central or pivot pier of the draw, measured at right angles to the axis of the channel: *Provided*, That the said draw shall be opened promptly on reasonable signal for the passage of boats, vessels, and other water craft: *And provided further*, That said company or corporation shall maintain at its own expense, from sunset to sunrise through the season of navigation, such lights or other signals on said bridge as the Light-House Board shall prescribe. The superstructure of said bridge shall be constructed of iron and steel, and be sufficiently supported by abutments and piers of solid masonry.

Provisos.
Opening draw.

Lights, etc.

SEC. 5. That all street and other railway companies, telegraph and telephone companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of cars and stringing wires over the same and over the approaches thereto upon the payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several street and other railway companies, or any of them, desiring such use shall fail to agree on the sum or sums to be paid, and on the rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War, upon hearing the allegations and proofs of the parties in question. And all owners and persons in charge of wagons and vehicles and animals of all kinds, and all foot passengers, shall have and be entitled to equal rights to passage and transit over said bridge, and over the approaches thereto, upon payment of a reasonable compensation for such use, such rate of compensation to be agreed upon by and between the common councils of the cities of Superior and Duluth and the owner or owners of said bridge; and in case the owner or owners of said bridge and the said common councils fail to agree on the sum or sums to be paid all matters of issue between them shall be decided by the Secretary of War, upon hearing of the allegations and proofs of the parties in question.

Use by other companies.

Compensation.

Foot and wagon passage.

Compensation.

SEC. 6. That the company or persons owning and holding such bridge shall, at any time after the completion thereof, sell and transfer the same to the city of Duluth, in the county of Saint Louis, in the State of Minnesota, and to the city of Superior, in the county of Douglas, in the State of Wisconsin, or to the said counties jointly, and surrender the entire control and management thereof, with all the rights and privileges and franchises thereto appertaining, upon payment to such holders and owners of the total amount expended up to the time of the transfer in and about the construction, maintenance, and repairs of said bridge and its approaches and accessory works, as well as expended in dredging the channel to and through the draw of such bridge, with interest thereon at the rate of seven per centum per annum, less the net income from the tolls; in which event, and in case of the due consummation of such transfer, the said counties or cities shall thenceforth be subject to all the obligations and conditions imposed by the provisions of this Act, and shall assume and pay at their maturity the unmatured obligations, if any, of the said company or persons, not exceeding in amount the purchase price of said bridge as herein provided, and the amount of such obligations so assumed, with the accrued interest thereon, shall be deducted from the amount of said purchase price, and the remainder only shall be paid to said company or persons: *Provided*, That said bridge and its approaches thereafter shall be made free of tolls to wagons, teams, and foot passengers, and street-railway cars.

Sale to Duluth Minn., or Superior, Wis., authorized.

Conditions.

Proviso.

Free passage.

Lawful structure and post route.

SEC. 7. That the bridge and accessory works constructed under this Act and according to its terms and limitations shall be a lawful structure, and shall be recognized and known as a post route upon which no higher charge shall be made for the transmission over the same of the mails, the troops, and munitions of war of the United States than the rate per mile paid for the transportation over the railroads or public highways leading to said bridge, and said bridge shall enjoy the rights and privileges of other post routes in the United Sates, and the United States shall have the right of way for postal telegraph purposes across said bridge.

Postal telegraph.

Amendment, etc.

SEC. 8. That the right to alter, amend, or repeal this Act is hereby expressly reserved; and the right to require any changes in said structure, at the expense of the owners thereof, whenever Congress shall decide that the public interests require it, is also expressly reserved.

Commencement and completion.

SEC. 9. That this Act shall be null and void if actual construction of the bridge therein authorized be not commenced within one year and completed within three years from the date of the passage of this Act.

Approved, April 24, 1894.

May 1, 1894.

CHAP. 67.—An Act To authorize the Saint Louis River Bridge Company and the Duluth Transfer Railway Company to construct, maintain, and operate a bridge over the Saint Louis River from a point at or near Grassy Point, in the village of West Duluth, Minnesota, to the most available point opposite, in the State of Wisconsin.

Saint Louis River Bridge Company and Duluth Transfer Railway Company may bridge Saint Louis River, Minn. and Wis.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Saint Louis River Bridge Company, a corporation organized and existing under the laws of the State of Wisconsin, and the Duluth Transfer Railway Company, a corporation created, organized, and existing under and by virtue of the laws of the State of Minnesota, and their respective successors in interest be, and are hereby, authorized to construct, maintain, and operate a bridge, with the approaches thereto, over the Saint Louis River, between the States of Minnesota and Wisconsin, extending from or near Grassy Point, West Duluth, in the State of Minnesota, to the most available point opposite in the city of Superior, in the county of Douglas, and State of Wisconsin. Said bridge shall be constructed to provide for the passage of cars, locomotives, and trains of railway companies and shall have laid thereon and thereover railroad tracks for the more perfect connection of any railroads that are or may be constructed to said bridge, or the place of its location, to the end that interchange of traffic may be encouraged and interstate commerce promoted and facilitated; and the same shall be so built as to provide for and permit of the passage thereover of the cars and rolling stock of street railway companies, wagons, carriages and vehicles of all kinds, animals, foot passengers, and travelers under such reasonable rules and regulations as may be prescribed by the said

Railway, wagon, and foot bridge.

companies authorized hereby to construct the same, or their successors in interest, and for such reasonable rates of toll as may be fixed by said companies, to be approved from time to time by the Secretary of War: *Provided, however*, That said bridge and its approaches shall be made free of tolls to wagons, teams, foot passengers, and street railways at the end of twenty years from the passage of this Act if not made free before the end of said time.

Toll.

Proviso.

Free passage.

SEC. 2. That the bridge to be built under this Act shall be constructed as a pivot drawbridge, with a draw over the main channel of said river, at an accessible and navigable point, to be approved by the Secretary of War, and with spans of not less than one hundred and seventy-five feet in length in the clear on each side of the central or pivot pier of the draw; and also a fixed span with a length of not less than one hundred and seventy-five feet to permit the passage of rafts under said bridge; and said draw shall be opened promptly, at reasonable signal, for the passage of boats, vessels, and other water craft whose construction shall be such as not to admit of their passage under the draw of said bridge when closed, but in no case shall unnecessary delay occur in the opening of said draw; and there shall be maintained by such corporations, at their own expense, from sunset to sunrise, such lights or other signals upon said bridge as the Light-House Board may prescribe; and there shall also be maintained, at their own expense, sheer booms or other proper protection to guide rafts, boats, vessels, and water craft through said draw spans; and the said company or companies may do any dredging necessary for confining the flow of water to a permanent channel or to the maintenance thereof at navigable depths.

Draw.

Opening draw.

Lights, etc.

Aids to navigation.

SEC. 3. That the bridge and accessory works and improvements constructed under this Act and according to its terms and limitations shall be a lawful structure, and said bridge shall be recognized and known as a post route upon which no higher charge shall be made for the transportation over the same of the mails, troops, and munitions of war of the United States than the rate per mile paid for their transmission over railroads and public highways leading to said bridge, and the United States shall have the right of way for postal and telegraph purposes across said bridge, free of charge.

Lawful structure and post route.

SEC. 4. That it shall be lawful for the said companies hereby authorized to construct the said bridge to make such contracts and agreements respecting the construction and maintenance of said bridge as they may desire, not in contravention of the provisions hereof, and may, if they so desire, contract and agree with each other as to their ownership and control of the respective portions of said bridge, to the end, if they so desire, that the said railway company may be invested with the ownership, control, management, and maintenance of that portion thereof devoted to railway traffic, and the said other company be invested with the ownership, management, control, and maintenance of the residue of said structure, or to the end

Construction contracts.

that the best and most feasible method may be by said companies devised for the ownership and maintenance of said structure; and it shall be lawful, in case the said companies hereby authorized to construct said bridge shall so desire, for them to enter into contract together, whereby either of said companies may construct the same under the authority hereby given, and enter into contract together as to the ownership, rights, and control of the respective parties in interest; but nothing herein shall relieve either of said companies or corporations from any liability for a failure to comply with the provisions of this Act.

Use by rail road companies.

SEC. 5. That all railroad companies desiring to use that portion of said bridge constructed for railroad purposes shall have and be entitled to equal rights and privileges in the passing over the same and in the use of the machinery and fixtures thereof and of the approaches thereto for a reasonable compensation, to be paid to the owner or owners thereof, and if the owner or owners of said bridge and the several railroad companies, or either or any of them desiring such use, shall fail to agree upon the sum or sums to be paid, and the rules and conditions to which each shall conform in using the same, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties, of which hearing each party shall have due notice, and the determination of the Secretary of War thereof shall be binding upon the parties to such controversy.

Compensation.

Use by street railways.

SEC. 6. That all street railway companies desiring to use that portion of said bridge constructed and applicable for such use shall have and be entitled to equal rights and privileges relative to the passage of their cars and rolling stock thereover and over the approaches thereto upon the payment of a reasonable compensation for such use; and in case the owner or owners of said bridge or any portion thereof, and the street railway company or companies so desiring to use the same, shall fail to agree upon the sum or sums to be paid upon the rules and conditions to which each shall conform in using the same, all matters at issue between them shall be decided by the Secretary of War in the manner provided in the last preceding section.

Compensation.

Transfer of franchise to Duluth and Superior.

SEC. 7. That the company or persons owning and holding such bridge shall, at any time after the completion thereof, sell and transfer the same, or such portion thereof as is not used for railway purposes, to the city of Duluth, in the county of Saint Louis, in the State of Minnesota, and to the city of Superior, in the county of Douglas, in the State of Wisconsin, or to the said counties jointly, and surrender the entire control and management thereof, with all the rights and privileges and franchises thereto appertaining, upon payment to such holders and owners of the total amount expended up to the time of the transfer in and about the construction, maintenance, and repairs of said bridge and its approaches and accessory works, as well as expended in dredging the channel to and through the draw of such bridge; and in case of the purchase of only a part

Transfer of part of bridge.

of said bridge then the amount to be paid shall be apportioned by agreement between the owners of said bridge, and the cities or counties purchasing it, or, in case of disagreement, by the Secretary of War, with interest thereon at the rate of seven per centum per annum, less the net income from the tolls, in which event, and in case of the due consummation of such transfer, the said counties or cities shall thenceforth be subject to all the obligations and conditions imposed by the provisions of this Act, and shall assume and pay at their maturity the unmatured obligations, if any, of the said company or persons, not exceeding in amount the purchase price of said bridge as herein provided; and the amount of such obligations so assumed, with the accrued interest thereon, shall be deducted from the amount of said purchase price, and the remainder only shall be paid to said company or persons: *Provided*, That said bridge and its approaches thereafter shall be made free of tolls to wagons, teams, and foot passengers and street railway cars.

Proviso. Free passage.

Free navigation.

SEC. 8. That in order that any bridge built under the authority of this Act may be constructed and built without any material interference with the security and convenience of navigation of said river, beyond what is necessary to carry into effect the rights and privileges hereby granted, and in order to secure compliance with the conditions herein specified, the said corporation so constructing the same shall, previous to commencing the work of construction of said bridge, submit the plans and location thereof, with a detailed map of the river at the proposed site of said bridge, and near thereto, exhibiting the depths and currents of said river, to the Secretary of War for his approval, together with such further information concerning said bridge and said river as may be deemed requisite by him; and until he approves the plans and location of said bridge it shall not be built. The Secretary of War, upon receiving such map and plans, shall proceed with due diligence to consider the same, and, upon being satisfied that the same conform to the prescribed conditions of this Act, shall notify said companies that he approves the same, and shall notify said companies of any changes or modifications necessary in order that the same be made to conform to said conditions; and the said companies, upon receiving such notification, may proceed to erect the said bridge in conformity with the approved plans and location and the conditions herein prescribed; and no change shall be made therein without the consent of the Secretary of War and his approval thereof: *Provided, however*, That the Secretary of War shall give, or cause to be given, to said corporations reasonable notice of the time and place of the consideration of said plans and maps by him or by any officer of his Department, and the said corporations shall have a right to appear with their engineers and attorneys, or either, before such officer, and be heard in behalf of said plans before him, as well as before any officer authorized by him to report upon the same.

Secretary of War to approve plans, etc.

Proviso. Consideration of plans, etc.

Litigation.

SEC. 9. That in case of any litigation arising by reason of any obstruction of the free navigation of said river, by reason of said bridge, the cause may be tried before the circuit court of the United States for the States of Minnesota or Wisconsin, and the said corporations herein authorized to construct said bridge, or either of them so constructing the same, under the authority herein granted, their or its successors and assigns, for the purpose of acquiring necessary rights of way for the construction of necessary abutments and approaches for said bridge, and the lines and tracks of railroad thereon, shall have the power to acquire the same by purchase, gift, or conveyance, or by the exercise of the power of eminent domain, and, for such latter purpose, may institute proceedings in the proper court having jurisdiction in each or either of said States wherein the premises sought to be condemned are located, or in the circuit court of the United States in the proper district or division of either of said States, said proceedings to be conducted in all respects in conformity with the provisions of law in such State or States, for the acquisition by condemnation of private property, and appropriating the same to public use, by corporations authorized to exercise the power of eminent domain.

Condemnation proceedings.

Commencement and completion.

SEC. 10. That if such bridge hereby authorized to be built shall not be commenced within one year and finished within three years from the date hereof, the rights and privileges hereby granted shall determine and cease.

Amendment, etc.

SEC. 11. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, May 1, 1894.

May 7, 1894.

CHAP. 69.--An Act To authorize the reconstruction of a bridge across the Niobrara River near the village of Niobrara, Nebraska, and making an appropriation therefor.

Niobrara River.

Appropriation for bridge across, at Niobrara, Nebr.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That for the purpose of reaching the Ponca and Yankton Sioux Indian reservations, and for carrying supplies thereto, the Secretary of War be, and he is hereby, authorized and directed without unnecessary delay to cause to be reconstructed across the Niobrara River near the village of Niobrara, Nebraska, the Government bridge recently destroyed by floods. Said bridge shall be a substantial wooden or iron bridge, with the necessary approaches, and the sum of seven thousand dollars, or so much thereof as may be necessary to reconstruct said bridge, is hereby appropriated out of any money in the Treasury not otherwise appropriated.

Contract.

SEC. 2. That no part of the appropriation made by this act shall be paid out of the Treasury until a contract is entered into with responsible parties, with good and sufficient sureties, to be approved by the Secretary of War, for the construction and completion of said bridge, including the approaches, at a cost not exceeding the sum hereby

appropriated. Said bridge, when reconstructed, shall be free to all travelers. Free bridge.

SEC. 3. That this act shall be in force from and after its passage and approval. Effect.

Approved, May 7, 1894.

CHAP. 70.—An Act To authorize the construction of a bridge over the Monongahela River in the city of Pittsburg. May 7, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the city of Pittsburg, a municipal corporation created by and existing under the laws of the Commonwealth of Pennsylvania, its successors and assigns, be, and they are hereby, authorized and empowered to construct, maintain, and operate a bridge over the Monongahela River, from a point on the south shore of said Monongahela River at or near Twenty-second street, in the Twenty-fifth ward of the city of Pittsburg, to a point on Brady street directly across said river, and on the north shore thereof and within the said city of Pittsburg, county of Allegheny, and Commonwealth of Pennsylvania. The said city of Pittsburg shall not commence the construction of its bridge, bridge piers, abutments, causeway, and other works over or in said Monongahela River until the location and plan of the same shall have been submitted to and approved by the Secretary of War. Pittsburg, Pa., may bridge Monongahela River.

SEC. 2. That any Act of Congress or part of an Act inconsistent herewith, so far as it affects the same, is hereby repealed. Inconsistent laws repealed.

SEC. 3. That any bridge authorized to be constructed under this Act shall be located and built under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall prescribe; and to secure that object the said city of Pittsburg shall submit to the Secretary of War, for his examination and approval, a design, plan, and drawing of the bridge, and a map of the location, giving for the space of one-half mile above and one-half mile below the proposed location the high and low water lines upon the banks of the river, the direction and strength of the currents at high and low water, with the soundings, accurately showing the bed of the stream, and the location of any other bridge or bridges; such map to be in sufficient detail to enable the said Secretary of War to judge of the proper location of said bridge, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be commenced or built; and should any change be made in the plans of said bridge during the progress of its construction, such changes shall be subject to the approval of the Secretary of War. The channel span of said bridge shall not be less than five hundred feet in length in the clear and the super- Secretary of War to approve plans, etc. Changes. Channel span.

structure shall not be less than fifty-three feet above the level of the water at pool full in said river.

Aids to navigation. SEC. 4. That the bridge herein authorized to be constructed shall be so kept, managed, and maintained as to afford proper means and ways for the passage of vessels, barges, or rafts, by day and night, and there shall be kept and displayed, by the owners thereof, from sunset to sunrise, such lights and other signals as the Light-House Board may prescribe; and such changes shall be made from time to time in the structure of said bridge as the Secretary of War may direct, at the expense of the owners of such bridge, in order the better to preserve free navigation of said river.

Lights, etc.

Commencement and completion. SEC. 5. That the bridge herein authorized shall be commenced by the said city of Pittsburg within one year and completed within three years from the date hereof; otherwise this act to be null and void.

Amendment, etc. SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, May 7, 1894.

May 12, 1894. CHAP. 76.—An Act To authorize the construction of a bridge across the Mississippi River at Red Wing, Minnesota.

Red Wing, Minn., may bridge Mississippi River. *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the city of Red Wing, in the State of Minnesota, a municipal corporation existing under the laws of the State of Minnesota, is hereby authorized and empowered to erect, establish, and maintain, or authorize the erection, establishment, and maintenance of a foot and wagon bridge across the Mississippi River at a point suitable to the interests of navigation, from a point near Bluff street, in the city of Red Wing, State of Minnesota, so as to connect with the opposite shore of said river in the State of Wisconsin; that said bridge shall not interfere with the free navigation of said river beyond what is necessary in order to carry into effect the rights and privileges hereby granted, and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river the cause may be tried before the circuit court of the United States in and for any district in which any portion of said bridge or obstruction touches. Said bridge shall be constructed to provide for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for such reasonable rates of toll as may be fixed by the said city of Red Wing from time to time and approved by the Secretary of War.

Foot and wagon bridge.

Free navigation.

Toll.

High bridge. SEC. 2. That any bridge built under the provisions of this Act shall be constructed as a high bridge, with a channel span giving a clear width of waterway of not less than three hundred and eighty feet and a clear headroom of not less than fifty-five feet above high-water mark, as understood at the point of location, and the clear headroom

under other than channel spans may be reduced to ten feet above high-water mark; and the piers of said bridge shall be parallel with the current of the river.

SEC. 3. That any bridge constructed under this act and according to its provisions and conditions shall be a lawful structure, over which may be transmitted the mails, troops, and munitions of war of the United States free of charge; and the United States shall have the right of way for postal telegraph purposes across said bridge. Lawful structure and post route. Postal telegraph.

SEC. 4. That the structure herein authorized shall be built and located under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall prescribe, and to secure that object the corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of the bridge and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the current, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as shall be required for a full and satisfactory understanding of the subject; and until the said plans and location of the bridge are decided by the Secretary of War to be such as will not materially affect the interest of navigation the bridge shall not be commenced or built; and should any change be made in the plan of said bridge during the progess of construction such change shall be subject to the approval of the Secretary of War; and the said structure shall at all times be so kept and managed as to offer reasonable and proper means for the passage of vessels through or under said structure; and for the safety of vessels passing at night there shall be displayed on said bridge, from the hours of sunset to sunrise, such lights as may be prescribed by the Light-House Board; and the said structure shall be changed or removed, at the cost and expense of the owners thereof, from time to time, as Congress may direct, so as to preserve the free and convenient navigation of said river; and the authority to erect and continue said bridge shall be subject to revocation and modification by law when the public good shall, in the judgment of Congress, so require, without any expense or charge to the United States. Secretary of War to approve plans, etc. Changes. Lights, etc.

SEC. 5. That the right to alter, amend, or repeal this Act is hereby expressly reserved. Amendment, etc.

SEC. 6. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within two years and completed within four years from the date thereof. Commencement and completion.

Approved, May 12, 1894.

May 28, 1894.

CHAP. 79.—An Act To amend the Act of June twenty-second, eighteen hundred and ninety-two, entitled "An Act to authorize the construction of a bridge across the Missouri River at the city of Yankton, South Dakota."

Bridge across Missouri River at Yankton, S. Dak.
Vol. 27, p. 56.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section six of the Act of June twenty-second, eighteen hundred and ninety-two, entitled "An Act to authorize the construction of a bridge across the Missouri River at the city of Yankton, South Dakota," is amended so as to read as follows:

Time for construction extended.

"SEC. 6. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within two years and completed within four years from the twenty second day of June, eighteen hundred and ninety-four."

Approved, May 28, 1894.

May 28, 1894.

CHAP. 80.—An Act Authorizing the Texarkana and Shreveport Railroad Company to bridge Sulphur River, in the State of Arkansas.

Texarkana and Shreveport Railroad Company may bridge Sulphur River, Ark.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Texarkana and Shreveport Railroad Company, its successors or assigns, be, and is hereby, authorized to construct and maintain a railway bridge and approaches thereto over and across Sulphur River in the State of Arkansas, at or near the point where the north and south line between sections twenty-seven and twenty-eight in township eighteen south, in range twenty-seven west, of the fifth principal meridian intersects said river near the south boundary line of said sections.

Railway, wagon, and foot bridge.

Said bridge shall be constructed to provide for the passage of railway trains and, at the option of said company, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for such reasonable rates of toll as may be approved from time to time by the Secretary of War.

Drawbridge.

That said bridge shall be a drawbridge with a draw over the main channel of the river at an accessible navigable point and with such clear width of opening and distance above high-water mark as may be prescribed by the Secretary of War, and, as nearly as practicable, said opening shall be accessible at all stages of water, and the piers and draw rest shall be parallel with and the bridge at right angles to the current of the river; and no riprap or other outside protection for imperfect foundations shall be permitted to approach nearer than four feet to the surface of the water at its extreme low stage, or otherwise to encroach upon the channel way provided for in this Act;

Opening draw.

and the said draw shall be opened promptly, upon reasonable signal, for the passing of boats; and said company shall maintain, at its own expense, from sunset till sunrise, throughout the season of navigation, such lights or other signals on said bridge as the Light-House Board may prescribe.

Lights, etc.

SEC. 2. That any bridge built under this Act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post route, upon which, also, no higher charge shall be made for the transmission over the same of mails, the troops of and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to said bridge; and it shall enjoy the rights and privileges of other post roads in the United States. Lawful structure and post route.

SEC. 3. That no bridge shall be erected or maintained under the authority of this Act which shall at any time substantially or materially obstruct the free navigation of said river; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstructions; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge. And in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States for the State of Arkansas, in whose jurisdiction said obstruction or bridge may be located: *Provided*, That nothing in this Act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers, or to exempt said bridge from the operation of the same. Free navigation. Litigation. *Proviso.* Existing laws not affected.

SEC. 4. That all railway companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any of them, desiring such use shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proof of the parties. Use by other companies. Term

SEC. 5. That the bridge authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of said bridge and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the currents at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the Secretary of War to approve plans, etc.

said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of said bridge during the progress of construction such change shall be subject to approval of the Secretary of War. And the said structure shall be changed at the cost and expense of the owners thereof from time to time as the Secretary of War may direct, so as to preserve the free and convenient navigation of said river, and the authority to erect and continue said bridge shall be subject to revocation by the Secretary of War whenever the public good, in his judgment, so requires.

Changes.

Amendments, etc.

SEC. 6. That the right to alter, amend, or repeal this act is hereby expressly reserved.

Commencement and completion.

SEC. 7. That this act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the approval of this act.

Approved, May 28, 1894.

May 28, 1894.

CHAP. 81.—An Act To authorize the construction of a bridge across the Missouri River at some point within one mile below and one mile above the present limits of the city of Jefferson, Missouri.

Jefferson City Bridge and Transit Company may bridge Missouri River.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Jefferson City Bridge and Transit Company, a corporation duly organized and existing under the laws of the State of Missouri, its successors and assigns, successors, grantees, mortgagees, and successors in interest, be, and are hereby, authorized to construct and maintain a bridge and approaches thereto across the Missouri River at Jefferson City, Missouri, between the counties of Cole and Callaway, at some point at least one-third of a mile from any other bridge, to be selected consistent with the interests of navigation, within one mile above and one mile below the present limits of the city of Jefferson, Missouri. Said bridge shall be constructed to provide for the passage of wagons and vehicles of all kinds, street-railway cars, motor cars, animals, foot passengers, and for all road travel, for such reasonable rates of toll and under such reasonable rules and regulations as may be prescribed by such corporation, its successors and assigns, and to be approved from time to time by the Secretary of War: *Provided*, That such bridge may be a combination railroad and wagon road bridge, so constructed as to provide for the passage of railway trains, engines and cars, wagons and vehicles of all kinds, foot and other passengers, animals and live stock, at the option of the corporation by which it may be built.

Wagon street railway and foot bridge.

Proviso. Railroad, etc., bridge.

Secretary of War to approve plans, etc.

SEC. 2. That said bridge shall not be built or commenced until the plans and specifications for its construction have been submitted to the Secretary of War for his approval, nor until he shall approve the plan and location of said bridge; and if any change be made in the plan or construction of said bridge at any time such change shall be subject

to the approval of the Secretary of War; and any change in the construction or any alteration of said bridge that may be directed at any time by Congress or the Secretary of War shall be made at the expense and cost of the owners thereof; that the said bridge shall be constructed without interference with the security and convenience of navigation of said river beyond what is necessary to carry out effectively the rights and privileges hereby granted, and in order to secure that object, the said corporation shall submit to the Secretary of War, for his examination and approval, a design of and drawings for said bridge and a map of the proposed location giving for the space of one mile above and one mile below such proposed location, the topography of the banks of the river with shore lines and soundings, and such other information as may be required for a full understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the construction of said bridge shall not be commenced.

SEC. 3. That said bridge shall be made with unbroken and continuous spans, and the spans thereof shall not be less than four hundred feet in length in the clear, and the main spans shall be over the main channel of the river. The lowest part of the superstructure of said bridge shall be at least fifty-five feet in the clear above the established standard high water grade line, and the bridge shall be at right angles to, and its piers parallel with the current of the river: *Provided*, That said company or corporation shall maintain at its own expense, from sunset to sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe.

Spans.

Proviso.

Lights, etc.

SEC. 4. That the Secretary of War is hereby authorized and directed, upon receiving such plan and other information and upon being satisfied that a bridge so built will conform to the requirements of this Act, to notify the company or corporation authorized to build the same that he approves of the same; and upon receiving such notification the said company or corporation may proceed to erect said bridge, conforming strictly to the approved plan and location, and should any change be made in the plan of the bridge or accessory works during the progress of the work thereon such change shall be subject likewise to the approval of the Secretary of War.

Notification of approval.

SEC. 5. That any bridge built under this Act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge, and it shall enjoy the rights and privileges of other post roads in the United States; and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies, and the United States shall have the right of way across said bridge and its approaches for postal telegraph purposes.

Lawful structure and post route.

Postal telegraph.

Use by street railroads.

SEC. 6. That all street railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of street railroad trains or cars over the same and over the approaches thereto upon the payment of a reasonable compensation for such use, and in case the owner or owners of said bridge and the several street railway companies, or any one of them, desiring such use fail to agree upon the sum or sums to be paid, and upon the rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War, upon a hearing of the allegations and proofs of the parties: *Provided*, That should said bridge be built for the passage of railroad trains, wagons, and foot passengers, street cars shall not be allowed to cross thereon except at the option of the bridge company. All railroad companies desiring the use of said bridge, should the bridge so built be a combination railroad and wagon-road bridge, shall have and be entitled to equal rights and privileges relative to the passage of railway trains or cars over the same and over the approaches thereto upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such passage should fail to agree upon the sum or sums to be paid, and upon the rules and conditions to which each shall conform in using such bridge, all matters at issue between them shall be decided by the Secretary of War, upon a hearing of the allegations and proof of the parties: *Provided further*, That nothing in this Act in regard to charges for passengers and freight across said bridge shall govern the Secretary of War in determining any question arising as to the sum or sums to be paid to the owners of said bridge by said companies for the use of said bridge.

Compensation.

Provisos.

Use by railroads.

Compensation.

Decision of Secretary of War.

Unobstructed navigation, etc.

SEC. 7. That Congress shall have the power at any time to alter, amend, or repeal this Act, and the Secretary of War, whenever he shall deem it necessary, may cause the owners of said bridge to remove all material and substantial obstructions to the navigation of said river by the construction of said bridge and its accessory works, or to prevent such obstruction; and the expense of altering said bridge or removing such obstruction shall be at the expense of the owners of the bridge.

Commencement and completion.

SEC. 8. That this Act shall be null and void if construction of said bridge shall not be commenced within one year and finished within three years from its passage.

Amendment, etc.

SEC. 9. That the right to alter, amend, or repeal this Act by Congress at any time is hereby expressly reserved.

Approved, May 28, 1894.

CHAP. 100.—An Act Authorizing the construction of a bridge over the Monongahela River, at the foot of Dickson street, in the borough of Homestead, in the State of Pennsylvania. June 7, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Braddock and Homestead Bridge Company, a corporation duly authorized under the laws of the Commonwealth of Pennsylvania, its successors and assigns, be, and they hereby are, authorized and empowered to construct, maintain, and operate a bridge over the Monongahela River, between a point at or near the foot of Dickson street, in the borough of Homestead, Allegheny County, to a point in the city of Pittsburg on the opposite side of said river, all within the State of Pennsylvania.

Braddock and Homestead Bridge Company may bridge Monongahela River, Pittsburg, Pa.

SEC. 2. That said bridge may be constructed for the passage of steam and electric motors and trains for passengers and freight, wagons and vehicles of all kinds, and for the transit of animals and for foot passengers, for toll, the rates of toll to be approved by the Secretary of War: *Provided*, That all companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of trains or cars over the same and over the approaches thereto, upon payment of reasonable compensation for such use; and in case of disagreement between the owner of said bridge and said companies in regard to the amount to be paid or the conditions to be observed all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties.

Railway, wagon, and foot-bridge.

Proviso. Use by other companies.

SEC. 3. That the said Braddock and Homestead Bridge Company, its successors and assigns, shall not begin the construction of its bridge, piers, abutments, causeways, and other works over, in, or on said river until the location and plan of the same shall have been submitted to and approved by the Secretary of War.

Commencement.

SEC. 4. That any bridge authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall prescribe, and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of the bridge and a map of the location, giving, for the space of one-half mile above and one-half mile below the proposed location, the high and low water lines upon the banks of the river, the direction and strength of the currents at low and high water, with the soundings, accurately showing the bed of the stream, and the location of any other bridge or bridges, such map to be sufficiently in detail to enable the Secretary of War to judge of the proper location of said bridge, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject, and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be commenced or built; and should any change be made in the plans of said bridge during the progress of its construction such changes

Secretary of War to approve plans, etc.

Changes.

shall be subject to the approval of the Secretary of War: *Provided*, That the channel span of said bridge shall not be less than five hundred feet in length and shall be elevated above pool full in said river at least fifty-three feet in the clear.

Proviso. Channel span.

Free navigation. SEC. 5. That said bridge herein authorized to be constructed shall be so kept and managed at all times as to afford proper means and ways for the passage of vessels, barges, or rafts, both by day or by night; and there shall be displayed on said bridge by the owners thereof, from sunset to sunrise, such lights or other signals as the Light-House Board may prescribe.

Lights, etc.

Commencement and completion. SEC. 6. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date hereof.

Amendment, etc. SEC. 7. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, June 7, 1894.

June 7, 1894.

CHAP. 101.—An Act To authorize the New York and New Jersey Bridge Companies to construct and maintain a bridge across the Hudson River between New York City and the State of New Jersey.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the New York and New Jersey Bridge Companies, heretofore incorporated by the States of New York and New Jersey, and existing under the laws of said States, are hereby authorized to construct, operate, maintain, and rebuild, in case of destruction, a bridge across the Hudson River between New York City, in the county and State of New York, and the State of New Jersey, subject to the laws of said States, respectively, upon the following terms, limitations, and conditions:

New York and New Jersey Bridge Companies may bridge Hudson River, New York City.

Location. First. That the location of said bridge shall be subject to approval by the Secretary of War, upon such examinations, hearings, and reports as he shall hereafter prescribe: *Provided*, That it shall not be located below Fifty-ninth street, New York City, nor above Sixty-ninth street, New York City.

Proviso. Limit.

Railroad tracks. Second. That the said companies may locate, construct, and maintain over such bridge and the approaches thereto railroad tracks for the use of railroads: *Provided*, That any railroad on either side of said river shall be permitted to connect its tracks with the said bridge approaches, and shall have equal rights of transit for its rolling stock, cars, passengers, and freight upon equal and equitable terms, and if a dispute as to the equality or equity of the terms shall arise it shall be submitted to and decided by the Secretary of War: *Provided*, That the location of all approaches of said bridge in the city of New York shall be approved by the commissioners of the sinking fund of the city of New York: *And provided further*, That no railroad or railroads shall be operated on the approaches of said bridge

Proviso. Connections with approaches. Approval by local authorities. Approaches. Operation of railroad.

companies in the city of New York, except on such approaches as shall have been approved by the sinking-fund commissioners of the city of New York: *Provided also*, That the term approaches as used in this Act shall be construed to include only such portion of the roadbed and superstructure, on either side of said bridge, as is necessary to reach the grade of the bridge from the grade of the streets at which said approaches begin to rise, in order to bring the two elevations together upon and by a grade of not less than twenty feet to the mile.

Definition of "approaches."

Third. That any bridge built under the authority of this Act shall be constructed with such length of span and at such elevation as the Secretary of War shall approve and require: *Provided, however*, That it shall afford, under any conditions of load or temperature, a minimum clear headway above high water of spring tides of not less than one hundred and fifty feet at the center of the span; and all the plans and specifications, with the necessary drawings of said bridge, shall be submitted to the Secretary of War for his approval, and before such approval the construction shall not be begun; and should any change be made in said plans during progress of construction, such changed plans shall be submitted to said Secretary and approved by him before made; and the President shall appoint a board, consisting of five competent, disinterested, expert bridge engineers, of whom one shall be either the Chief of Engineers or any member of the Corps of Engineers of the United States Army, and the others from civil life, who shall, within thirty days after their appointment, meet together and, after examination of the question, shall, within sixty days after their first meeting, recommend what length of span, not less than two thousand feet, would be safe and practicable for a railroad bridge to be constructed over said river, and file such recommendation with the Secretary of War, but it shall not be final or conclusive until it has received his written approval. In case any vacancy shall occur in said board, the President shall fill the same. The compensation and expenses of said board of engineers shall be fixed by the Secretary of War and paid by the said bridge companies, which said companies shall deposit with the Secretary of War such sum of money as he may designate and require for such purpose: *Provided, always*, That nothing herein contained shall be construed as preventing the said board of engineers from meeting, investigating, and filing their recommendation after the expiration of said time herein mentioned.

Construction.

Provisos.

Minimum height.

Secretary of War to approve plans, etc.

Engineer commission to report on span, etc.

Minimum length.

Compensation.

Time of filing report.

Fourth. The companies operating under this law shall maintain on the bridge, at their own expense, from sunset to sunrise, such lights and signals as the United States Light-House Board may prescribe.

Lights, etc.

Fifth. The said company or companies availing themselves of the privileges of this Act shall not charge a higher rate of toll than authorized by the laws of the State of New York or New Jersey, and the mails and troops of the

Toll.

United States shall be transported free of charge over said bridge.

Subject to interstate-commerce law. Lawful structure and post route.

Sixth. That said company or companies shall be subject to the interstate-commerce law, and to all amendments thereof, and when such bridge is constructed under the provisions of this Act it shall be a lawful military and post road and a lawful structure.

Acceptance, plans, etc., to be filed with Secretary of War.

Seventh. That the said company or companies availing themselves of the privileges of this Act shall file an acceptance of its terms with the Secretary of War, and shall submit to the Secretary of War, within one year after the passage of this Act, for examination and approval, drawings showing plan and location of the bridge and its approaches; and the construction of said bridge shall be commenced within one year after said location and plans have been approved of, as herein provided; and said company or companies shall expend, within the first year after construction has commenced, as herein required, not less than two hundred and fifty thousand dollars in money, and in each year thereafter not less than one million of dollars in money in the actual construction work of said bridge, which shall be reported to the Secretary of War; and the said bridge shall be completed within ten years from the commencement of the construction of the same, as herein required; and, unless the actual construction of said bridge shall be commenced, proceeded with, and completed within the time and according to the provisions herein provided, this Act shall be null and void.

Commencement and completion.

Yearly expenditure.

Amendment, etc.

The right to amend, alter, modify, or repeal this Act is hereby reserved.

Approved, June 7, 1894.

June 8, 1894.

CHAP. 102.—An Act To amend section eight of "An Act to authorize the construction of a bridge across the Calumet River," approved March first, eighteen hundred and ninety-three.

Bridge across Calumet River, Cook County, Ill. Vol. 27, p. 515.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section eight of "An Act to authorize the construction of a bridge across the Calumet River," approved March first, eighteen hundred and ninety-three, be, and is hereby, amended so that the time within which the actual construction of said bridge may be commenced is hereby extended for the period of one year, and the time for the completion of said bridge is hereby extended for the period of three years from the date of the approval of this Act.

Time for constructing extended.

Amendment, etc.

The right of Congress to alter, amend, or repeal this Act is hereby reserved.

Approved, June 8, 1894.

CHAP. 103.—An Act To authorize the Missouri River Power Company of Montana to construct a dam across the Misouri River.

June 8, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the consent of the Government is hereby given to the Missouri River Power Company of Montana, its successors or assigns, to construct across the Missouri River, at some point at or near the southeast corner of Township Eleven north, of Range Two west, Montana meridian, to be approved by the Secretary of War, a dam, canal, and the appurtenances thereof, for water power and other purposes, and in connection therewith a footbridge or bridges for public use. Said dam shall be constructed under the supervision and control of the Secretary of War, and before the same shall be commenced the plans and specifications shall be approved by the Secretary of War. The dam shall be furnished with a suitable boom and log sluice, and the company, or its successors and assigns, shall execute to the United States, with sureties approved by the Secretary of War, a bond in such sum as the Secretary may determine, conditioned to indemnify the United States against all claims for damages for overflow or otherwise caused by the construction of said dam.

Missouri River Power Company may dam Missouri River, Montana.

Secretary of War to approve plans, etc.

Sluice, etc.

SEC. 2. That the United States shall be secured a free right of way for constructions and approaches to said dam for transferring boats and freight around the same, and a free use of water power for operating such construction works.

Government use, etc.

SEC. 3. That the right to alter, amend, or repeal this Act is hereby expressly reserved, and the rights and privileges hereby granted to said Missouri River Power Company shall expire at the end of fifty years from and after the approval of this Act.

Amendment, etc.

Approved, June 8, 1894.

CHAP. 105.—An Act To authorize the Pennsylvania and New Jersey Railroad Companies, or either of them, to construct and maintain a bridge over the Delaware River between the States of New Jersey and Pennsylvania.

June 14, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Pennsylvania and New Jersey Railroad Company, organized under the authority of the State of Pennsylvania, and the Pennsylvania and New Jersey Railroad Company, organized under the authority of the State of New Jersey, or either of said companies, are hereby authorized to locate, build, maintain, equip, and operate a bridge and the appurtenances and works connected therewith across the Delaware River between a point in the city of Philadelphia and State of Pennsylvania above the foot of Roxborough street and within a distance of two miles from the point at which the Frankford Creek enters the said Delaware River, and a point in the State of New Jersey above

Pennsylvania and New Jersey Railroad Companies may bridge Delaware River, Philadelphia.

Railroad, etc., bridge.

the shore end of the Fishers Point Dyke and within two miles from the point where the Pensauken Creek enters the said river, and to lay one or more tracks thereon for the connection of railroads on either side of said river (and may, at any time, at its or their option, also adapt and use said bridge for ordinary travel) in order to facilitate interstate commerce and the transportation of persons and property, and for postal, military, and other purposes. Said bridge shall be constructed with a channel span of five hundred feet in length, having a clear headroom at high water of forty feet and a draw span with a clear waterway of one hundred and twenty-five feet on each side of the pier, the length of each of the remaining spans not to be less than three hundred feet: *Provided*, That said draw shall be opened promptly upon reasonable signal for the passage of vessels and boats.

Spans.

Proviso. Opening draw.

Secretary of War to approve plans, etc.

SEC. 2. That the said company or companies shall, at least three months previous to the erection of the said bridge, submit to the Secretary of War a plan of the bridge, with a detailed map showing the proposed site of the bridge and the river for a distance of one mile above and one mile below such site, with such other information as the Secretary of War may require for a full and satisfactory understanding of the subject; and he shall thereupon approve said plan or such modification thereof as he may deem necessary for the security of navigation, and upon approval thereof he shall so notify the said company, or companies, which shall thereupon have the authority to proceed with the construction of said bridge; but until the Secretary of War approves the plan of said bridge the erection of the same shall not be commenced. And no change shall be made in the plan during the progress of such work except with the approval of the Secretary of War.

Commencement and completion.

SEC. 3. That if the company or companies shall fail to present plans to the Secretary of War for a period of more than one year after the approval of this Act, or shall fail to commence the construction of said bridge within two years after the approval of the Secretary of War, or shall fail to complete the same within seven years after such approval, then, in either of said events, this Act shall be null and void.

Lawful structure and post road.

Tolls.

SEC. 4. That the said bridge and the railroads thereover constructed under the provisions of this act shall be a lawful structure, and shall be recognized and known as a post road. Reasonable tolls may be collected by said company or companies for passage thereover, but no higher charge shall be made for the transmission of the mails, troops, and munitions of war of the United States than the rate per mile paid for their transportation over the railroads or public highways leading to said bridge; and the United States shall have the right of way for postal telegraph purposes across the bridge: *Provided*, That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railroad trains or cars over the same, and over the approaches to the same, upon the payment of a reason-

Postal telegraph.

Proviso.

Use by other companies.

able compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such use shall fail to agree upon the sum or sums to be paid, and upon the rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties. Compensation.

SEC. 5. That the owner or owners of said bridge shall maintain on the same, at their own expense, from sunset to sunrise, such lights or signals as the United States Light-House Board shall prescribe. Lights, etc.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved. Amendment, etc.

Approved, June 14, 1894.

CHAP. 107.—An Act To amend an Act to authorize construction of a bridge at Burlington, Iowa, approved August sixth, eighteen hundred and eighty-eight, and amended by Act approved February twenty-first, eighteen hundred and ninety. June 19, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the time for the commencement and completion of said bridge authorized by said Act, entitled "An Act to authorize the construction of a railroad, wagon, and foot-passenger bridge at Burlington, Iowa," approved August sixth, eighteen hundred and eighty-eight, and amended by Act approved February twenty-first, eighteen hundred and ninety, be, and are hereby, each extended two years from the passage of this act. Bridge across Mississippi River, Burlington, Iowa. Vol. 25, p. 360; vol. 26, p. 12. Time for construction extended.

Approved, June 19, 1894.

CHAP. 118.—An Act Making Labor Day a legal holiday. June 28, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the first Monday of September in each year, being the day celebrated and known as Labor's Holiday, is hereby made a legal public holiday, to all intents and purposes, in the same manner as Christmas, the first day of January, the twenty-second day of February, the thirtieth day of May, and the fourth day of July are now made by law public holidays. Labor Day. To be a public holiday. R. S. D. C., sec. 993, p. 116.

Approved, June 28, 1894.

CHAP. 120.—An Act To authorize the city of Hastings, Minnesota, to construct and maintain a wagon bridge over the Mississippi River. June 29, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the city of Hastings, a municipal corporation existing under the laws of the State of Minnesota, be, and is hereby, authorized to construct and maintain, at a point suitable Hastings, Minn., may bridge Mississippi River.

to the interest of navigation, a wagon or a combined wagon and foot bridge and approaches thereto across the Mississippi River from a point at or near the foot of Sibley street, in the said city of Hastings, Minnesota, or at such other point in said city as the city council thereof, with the approval of the Secretary of War may direct, on the west bank to a point at or near the graded road nearly opposite on the east bank: *Provided*, That said bridge shall not interfere with the free navigation of said river, beyond what is necessary to carry into effect the rights and privileges hereby granted; and in case of any litigation arising from any obstruction, or alleged obstruction, to the free navigation of said river, or damage resulting from the same, the cause may be tried before the circuit court of the United States in and for any district in which any portion of said bridge or obstruction touches.

Proviso. Free navigation. Litigation.

High bridge.

SEC. 2. That any bridge built under this Act shall be constructed as a high bridge with a channel span giving a clear width of waterway of not less than three hundred feet and a clear head room of not less than fifty-five feet above high-water mark, and the clear head room under other than channel spans may be reduced to thirty-five feet above high-water mark.

Lawful structure and post route.

SEC. 3. That any bridge constructed under this Act, according to its limitations, shall be a lawful structure, and shall be known as a post route, and the same is hereby declared to be a post route, upon which no charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States; and the United States shall have the right of way for postal-telegraph purposes across said bridge. For the passage of all kinds of vehicles, for the transit of all kinds of animals, and for the passage of foot passengers the said bridge shall be free to the public.

Postal telegraph. Free passage.

Secretary of War to approve plans etc.

SEC. 4. That the structure herein authorized shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said city shall submit to the Secretary of War for examination and approval a design and drawing of the bridge and a map of the location, giving the topography of the banks of the river, the shore line at high and low water, and the soundings, accurately showing the bed of the stream, and shall furnish such other information as shall be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are decided by the Secretary of War to be such as will not materially affect the interests of navigation, the bridge shall not be commenced or built. And should any change be made in the plan of said bridge during the progress of construction such changes shall be subject to the approval of the Secretary of War. And the said bridge shall be constructed with such aids to the passage of said bridge, in the form of booms, dikes, piers, or other suitable and proper structures for confining the flow of water to a permanent and easily navigated channel, and for the guiding of

Changes.

Aids to navigation.

rafts, steamboats, and other water craft safely under said bridge, as the Secretary of War shall prescribe and at any time order to be constructed and maintained at the expense of the city of Hastings; and the said structure shall be at all times so kept and managed as to offer reasonable and proper means for the passage of vessels and other water craft under said structure; and for the safety of vessels passing at night there shall be displayed on said bridge, from the hours of sunset to sunrise, such lights or other signals as may be prescribed by the Light-House Board. And the said structure shall be changed or removed at the cost and expense of the said city of Hastings, from time to time, as Congress may direct, so as to preserve the free and convenient navigation of said river; and the authority to erect and continue said bridge shall be subject to revocation and modification by law when the public good shall, in the judgment of Congress, so require, without any expense or charge to the United States.

Lights, etc.

SEC. 5. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Amendments, etc.

SEC. 6. That this Act shall be null and void if actual construction on the bridge herein authorized be not commenced within two years, and completed within three years from date thereof.

Commencement and completion.

Approved, June 29, 1894.

CHAP. 121.—An Act Granting certain rights over Lime Point military reservation in the State of California.

July 2, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby granted to the citizens of the town or city of Sausalito, Marin County, California, the right to occupy and improve for the purposes of a road only for the use and benefit of the citizens of the United States, and for no other purposes whatever, a portion of the tract of land owned by the United States in the State of California, known as the Lime Point military reservation, upon the following conditions and provisions, namely:

Lime Point military reservation, Cal.

Right of way to Sausalito.

First. That no use of said land for the purposes of said road shall be begun by the said citizens of Sausalito as aforesaid until after general plans of said improvement shall have been submitted to the Secretary of War and shall have been approved by him and the portion of said tract of land owned by the United States to be used for such stated purposes shall have been specially designated by him, and that no changes of the natural surface of the ground shall be made nor improvements of any sort begun until the extent and plans of such proposed work shall have been described in detail to the Secretary of War and shall have received his approval.

Plans to be approved by the Secretary of War.

Second. That the United States reserves the power to make and enforce regulations concerning the occupation and use of the portion of the Lime Point military reserva-

Regulations.

tion covered by this grant and concerning the use of the road thereon.

Reversion.

Third. That the United States reserves to itself the fee in said tract and the right to resume immediate and entire possession and use whenever the first of the above provisions shall have been violated, and also to resume possession of and occupy any portion thereof, or to suspend the use of said road whenever, in the judgment of the Secretary of War, the exigency arises that should require such action for public defense or otherwise, or whenever Congress may determine other disposition of said tract, without any claim for compensation to said citizens of Sausalito for improvement thereon or damage on account thereof.

Approved, July 2, 1894.

July 6, 1894.

CHAP. 127.—An Act Authorizing the Minneapolis Gas Light Company, of Minneapolis, Minnesota, to lay submerged gas pipes across the Mississippi River at Minneapolis.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the consent of Congress is hereby granted to the Minneapolis Gas Light Company, of Minneapolis, Minnesota, to lay a submerged gas main across the Mississippi River, under the bed thereof, to conduct gas from its gas works on the west side of said river to the east division of Minneapolis on the east side of said river, at some point between the foot of the Falls of Saint Anthony and the Washington avenue bridge across said river, the location and manner of laying said gas main to be approved by the Secretary of War before the work is commenced.

Mississippi River.
Minneapolis Gas Light Company may lay gas main under.

Approved, July 6, 1894.

July 11, 1894.

CHAP. 129.—An Act To amend an Act entitled "An Act to authorize the Oregon and Washington Bridge Company to construct and maintain a bridge across the Columbia River, between the State of Oregon and the State of Washington, and to establish it as a post road."

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That "An Act to authorize the Oregon and Washington Bridge Company to construct and maintain a bridge across the Columbia River, between the State of Oregon and the State of Washington, and to establish it as a post road," approved March twenty-fourth, eighteen hundred and ninety, be, and the same is hereby, re-enacted and declared to be and to have been in full force and effect from and after March twenty-fourth, eighteen hundred and ninety-four. Section twelve of said Act, which provides that said Act shall be null and void if actual construction of the bridge therein authorized be not commenced within two years and completed within four years from the date of

Bridge across Columbia River. La Camas, Wash.
Vol. 26, p. 28; Vol. 27, pp. 19, 87.

the approval thereof, shall be, and the same is hereby, so amended that the time within which said bridge is required to be commenced shall be within two years from March twenty-fourth, eighteen hundred and ninety-four, and the time within which it is required that said bridge be completed shall be within four years from the twenty-fourth day of March, eighteen hundred and ninety-four.

Time for construction extended.

Approved, July 11, 1894.

CHAP. 136.—An Act To authorize the construction of a wagon and foot bridge across the South, or Main, Canadian River at or near the town of Noble, in Oklahoma Territory.

July 16, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the South Canadian Bridge Company, a corporation created by or under the laws of the Territory of Oklahoma, its successors or assignees, be, and is hereby, authorized to contruct, maintain, and operate a bridge or bridges for the passage of vehicles of all kinds, animals, and foot passengers across the South, or Main, Canadian River at or near the Town of Noble, and at any other point where said river borders Oklahoma and Indian Territories, so as to connect with the opposite shore of the said river in the Chickasaw Nation, Indian Territory.

South Canadian Bridge Company may bridge South Canadian River, Noble, Okla.

SEC. 2. That any bridge or bridges built under the provisions of this Act shall be a lawful structure or structures, and shall be recognized and known as a post route upon which no higher charge shall be made for the transmission over the same of the mails, troops, and munitions of war of the United States passing over said bridge or bridges than the rate per mile paid for the transportation over the public highways leading to said bridge or bridges; and equal privileges in the use of said bridge shall be granted to all telegraph companies; and the United States shall have the right of way across said bridges and approaches for postal-telegraph purposes: *Provided*, That before the construction of any bridge herein authorized is commenced the said company shall submit to the Secretary of War, for his examination and approval, a design and drawing of such bridge and a map of the location, giving sufficient information to enable the Secretary of War to fully and satisfactorily understand the subject, and unless the plan and location of such bridge are approved by the Secretary of War the structure shall not be built: *Provided also*, That any bridge constructed under authority of this Act shall at all times be so kept and managed as to offer reasonable and proper means for the passage of vessels and other watercraft through or under said structure; and for the safety of vessels passing at night there shall be displayed on such bridge, from sunset to sunrise, such lights or other signals as may be prescribed by the Light-House Board.

Lawful structures and post routes.

Postal telegraph.

Provisos.

Secretary of War to approve plans, etc.

Free navigation.

Lights, etc.

SEC. 3. That said South Canadian Bridge Company shall have the right to charge and collect a reasonable rate of

Toll.

toll, not exceeding the rate limited by the law of Oklahoma Territory.

Commencement and completion. SEC. 4. That this Act shall be null and void if actual construction of the bridges herein authorized be not commenced within one year and completed within three years from the date of approval hereof.

Amendment, etc. SEC. 5. That Congress hereby expressly reserves the right to alter, amend, or repeal this Act.

Approved, July 16, 1894.

July 23, 1894. **CHAP. 148.**—An Act Authorizing the construction of a bridge over the Monongahela River at the foot of Main street, in the borough of Bellevernon, in the State of Pennsylvania.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That

Bellevernon Bridge Company may bridge Monongahela River, Pa. Vol. 27, p. 475. the Bellevernon Bridge Company, a corporation duly authorized under the laws of the Commonwealth of Pennsylvania, its successors and assigns, be, and they hereby are, authorized and empowered to construct, maintain, and operate a bridge over the Monongahela River between a point at or near the foot of Main street, in the borough of Bellevernon, Fayette County, to a point in Washington County on the opposite side of said river, all within the State of Pennsylvania.

Secretary of War to approve plans, etc. SEC. 2. That the said Bellevernon Bridge Company, its successors and assigns, shall not begin the construction of its bridge, piers, abutments, causeways, and other works over, in, or on said river until the location and plan of the same shall have been submitted to and approved by the Secretary of War.

Repeal. SEC. 3. That any Act of Congress or part of an Act inconsistent herewith, so far as it affects the same, is hereby repealed.

Submission of design, etc. SEC. 4. That any bridge authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall prescribe, and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of the bridge and a map of the location, giving, for the space of one-half mile above and one-half mile below the proposed location, the high and low water lines upon the banks of the river, the direction and strength of the currents at low and at high water, with the soundings accurately showing the bed of the stream, and the location of any other bridge or bridges, such map to be sufficiently in detail to enable the Secretary of War to judge of the proper location of said bridge, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject, and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be commenced or built; and should any

Change. change be made in the plans of said bridge during the progress of its construction, such

changes shall be subject to the approval of the Secretary of War: *Provided*, That the channel span of said bridge shall be in length not less than three hundred and fifty feet in the clear and shall be elevated at least fifty-four feet above the surface of the river at pool full.

Proviso. Channel span

SEC. 5. That said bridge herein authorized to be constructed shall be so kept and managed at all times as to afford proper means and ways for the passage of vessels, barges, or rafts, both by day and by night; and there shall be displayed on said bridge by the owners thereof, from sunset to sunrise, such lights or other signals as the Light-House Board may prescribe; and such changes shall be made from time to time in the structure of said bridge as the Secretary of War may direct, at the expense of the said bridge company, in order the more effectually to preserve the free navigation of said river.

Aids to navigation.

Lights, etc.

SEC. 6. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date hereof.

Commencement and completion.

SEC. 7. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Amendment, etc.

Approved, July 23, 1894.

CHAP. 153.—An Act To authorize the construction of a bridge across the Mississippi River from a point within the limits of the city of Dubuque, in the State of Iowa, known as Eagle Point, to the opposite bank of said river in the county of Grant and State of Wisconsin.

July 23, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Dubuque and Wisconsin Bridge Company, a corporation duly organized and incorporated under the laws of the State of Iowa, its successors and assigns, be, and is hereby, authorized to construct and maintain, at a point suitable to the interests of navigation, a bridge for the passage of vehicles of all kinds, animals, and foot passengers across the Mississippi River from a point at or near Eagle Point, in the city of Dubuque, in the State of Iowa, to the opposite shore of said river in the county of Grant, in the State of Wisconsin. That said bridge shall not be built within two miles of any other bridge on said river, following the course of the main channel. That the location and plan, or manner of constructing said bridge, shall be subject to the approval of the Secretary of War, and until decided by him to be such as will not materially affect the interests of navigation, the said bridge shall not be built. And there shall be submitted to the Secretary of War, for his examination and approval, a design and drawing of the proposed bridge and a map of the location, giving, for the space of a mile above and below the proposed location, the topography of the banks of the river, the shore line at high and low water, the direction and strength of the currents at all stages, and the soundings

Dubuque and Wisconsin Bridge Company may bridge Mississippi River, Dubuque, Iowa.

Wagon and footbridge.

Location.

Secretary of War to approve plans, etc.

accurately showing the bed of the stream, the location of any other bridge or bridges, and all other information required, and should any change be made in the plan of said bridge during the progress of construction, such change shall be subject to the approval of the Secretary of War; and the said structure shall at all times be so kept and managed, and provided with such guard fences, sheer booms, and other structures, as to offer reasonable and proper means for the passage of vessels and other floating craft through or under said structure; and for the safety of vessels passing at night there shall be displayed on said bridge, from the hours of sunset to sunrise, such lights as may be prescribed by the Light-House Board; and the said structure shall be changed or removed, at the cost and expense of the owners thereof, from time to time, as Congress may direct, so as to preserve the free and convenient navigation of said river; and the authority to erect and continue said bridge shall be subject to revocation and modification by law when the public good, in the judgment of Congress, so requires, without any expense or charge to the United States. That said bridge shall not interfere with the free navigation of said river beyond what is necessary in order to carry into effect the rights and privileges hereby granted; and in case of any litigation arising from any obstruction, or alleged obstruction, to the free navigation of said river the cause may be tried before the circuit court of the United States in and for any district in which any portion of said bridge or obstruction is located.

Aids to navigation.

Lights, etc.

Free navigation.

Litigation.

Spans.

SEC. 2. That said bridge, between the Iowa shore and the lowlands or islands on the Wisconsin side of the river, shall be constructed with unbroken and continuous spans, and the main span shall be over the main navigable channel of the river, and shall give a clear width of waterway not less than three hundred and fifty feet, and shall give clear headroom the full length of said span of not less in any case than fifty-five feet above extreme high-water mark, as understood at the point of location. The remaining spans shall each give a clear width of waterway not less than two hundred feet and a clear headroom not less in any case than fifteen feet between extreme high-water mark and the lower chords of the superstructure. Said bridge shall be constructed at right angles to, and its piers parallel with, the current of the river.

Channel span.

Toll.

SEC. 3. That said Dubuque and Wisconsin Bridge Company shall have the right to charge and collect a reasonable rate of toll for the passage across said bridge of vehicles, animals, and foot passengers, and travelers, subject to approval by the Secretary of War.

Commencement and completion.

SEC. 4. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date of the passage hereof.

Lawful structure and post route.

SEC. 5. That the bridge built under this Act, and subject to its limitations, shall be a lawful structure, and shall be known and recognized as a post route, and it shall enjoy

the rights and privileges of other post roads in the United States; and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies; and the United States shall have the right of way across said bridge and its approaches for postal-telegraph purposes. Postal telegraph.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved. Amendment, etc.

Approved, July 23, 1894.

CHAP. 162.—An Act To authorize the construction of a bridge across the Missouri River at or near the city of Lexington, Missouri. July 26, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Lexington Bridge and Terminal Company, a corporation existing under the laws of the State of Missouri, its assigns, grantees, successors, and legal representatives, be, and is hereby, authorized to build, own, operate, and maintain a bridge and approaches thereto over the Missouri River at or near the city of Lexington, in said State of Missouri. Said bridge shall be constructed to provide for the passage of railway trains, and, at the option of the persons by whom it may be built, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers for such reasonable rates of toll as may be approved from time to time by the Secretary of War; and in case of any litigation concerning any alleged obstruction to the free navigation of said river on account of said bridge, the cause may be tried before the circuit court of the United States in whose jurisdiction any portion of said obstruction or bridge is located. Lexington Bridge and Terminal Company may bridge Missouri River, Lexington, Mo. Railway, wagon, and foot bridge. Toll. Litigation.

SEC. 2. That any bridge constructed under this Act and according to its limitations shall be a lawful structure and shall be recognized and known as a post route, upon which, also, no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for their transportation over the railroads or public highways leading to said bridge; and the United States shall have the right of way for postal telegraph and telephone purposes across said bridge. Lawful structure and post-route. Postal telegraph.

SEC. 3. That said bridge shall be made with unbroken and continuous spans and shall not be of less elevation in any case than fifty feet above high-water mark, as understood at the point of location, to the lowest member of the bridge superstructure, nor shall the spans of said bridge over the waterway of said river be less than four hundred feet in length in the clear, and the piers of said bridge shall be parallel with the current of said river, and the bridge itself at right angles thereto: *Provided*, That in case the approach and passage under the channel span of said bridge be found at any time dangerous or difficult of access by the river traffic, the owners of said bridge shall Construction. *Provisos.* Aids to navigation.

construct at their own expense, such works of channel regulation and such aids to navigation as the Secretary of War shall order, to render the approach and passage reasonably safe and easy: *Provided also*, That the said company or corporation shall maintain, at its own expense, from sunset to sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe.

Lights, etc.

Use by railroad companies.

SEC. 4. That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for its use; and in case the owner or owners of said bridge and the several railroad companies, or any of them, desiring such use shall fail to agree upon the sum or sums to be paid, and to rules and conditions to which each shall conform in using such bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and the proof of the parties.

Terms.

Secretary of War to approve plans, etc.

SEC. 5. That any bridge authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawing of the bridge, and a map of the location, giving for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the current at all stages, and the soundings, accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as shall be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of said bridge during the progress of construction, such change shall be subject to the approval of the Secretary of War; and if said bridge is not commenced within one year and completed within three years from the passage of this Act, the rights and privileges hereby granted shall be null and void.

Changes.

Commencement and completion.

Amendment, etc.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved, and the right to require any changes in the structure or its entire removal, at the expense of the owners thereof, whenever Congress decides that the public interest requires it, is also expressly reserved.

Approved, July 26, 1894.

July 30, 1894.

CHAP. 170.—An Act Granting the use of certain land to the town of Castine, Maine, for a public park.

Castine, Me.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby granted to the town of Castine, in the State

of Maine, the right to occupy, improve, and control, for the purposes of a public park for the use and benefit of the citizens of the United States, and for no other purpose whatever, the tract of land owned by the United States situated in the extreme southerly part of said town of Castine, containing three acres, more or less, and known as the "Fort Madison lot"—said tract being more fully described in the deed of Joseph and Phebe Perkins, conveying the said land to the President of the United States, dated April first, eighteen hundred and nine, which deed is recorded in the records of Hancock County, Maine, book numbered twenty-seven, page one hundred and five—upon the following conditions and provisions, namely: Land granted for public park.

First. That the said town of Castine shall ascertain by proper survey and accurately mark in a permanent manner the boundaries of said tract of land according to the description given in said deed; that no use of said land shall be begun by the said town until after general plans of said improvement shall have been submitted to and approved by the Secretary of War. Survey. Approval by Secretary of War.

Second. That said town of Castine shall have and exercise power to make and enforce police regulations concerning said tract and shall properly protect all said property from injury. Protection.

Third. That the United States reserves to itself the fee in said tract and the right to resume immediate and entire possession whenever either of the above provisions shall have been violated, and also to resume possession and occupy any portion thereof whenever, in the judgment of the President, the exigency arises that should require the use and appropriation of the same for public defense or otherwise, or for such other disposition as Congress may determine, without any claim for compensation to said town for improvement thereon or damage on account therof. Fee, etc., reserved.

Approved, July 30, 1894.

CHAP. 174.—An Act Making appropriations for the legislative, executive, and judicial expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, and for other purposes. July 31, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, in full compensation for the service of the fiscal year ending June thirtieth, eighteen hundred and ninety-five, for the objects hereinafter expressed, namely: Legislative, executive, and judicial expenses appropriations.

* * * * * * *

WAR DEPARTMENT.

War Department.

* * * * * * *

OFFICE OF THE CHIEF OF ENGINEERS: Chief clerk, two thousand dollars; four clerks of class four; two clerks of class three; three clerks of class two; three clerks of Engineer office.

class one; one clerk, at one thousand dollars; one assistant messenger; and two laborers; in all, twenty-three thousand two hundred and forty dollars.

Draftsmen, etc. And the services of skilled draftsmen, civil engineers, and such other services as the Secretary of War may deem necessary, may be employed only in the office of the Chief of Engineers to carry into effect the various appropriations for rivers and harbors, fortifications, and surveys to be paid from such appropriations: *Proviso.* Limit. *Provided*, That the expenditures on this account for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, shall not exceed seventy-two thousand dollars; and that the Secretary of War shall each year, in the annual estimates, report to Congress the number of persons so employed and the amount paid to each. Report.

* * * * * * *

Public buildings and grounds.

PUBLIC BUILDINGS AND GROUNDS.

Clerk, messenger, gardener. OFFICE OF PUBLIC BUILDINGS AND GROUNDS: For one clerk, one thousand six hundred dollars; one messenger; one public gardener, one thousand eight hundred dollars; in all, four thousand two hundred and forty dollars.

Overseers, etc. For overseers, draftsman, foremen, mechanics, gardeners, and laborers employed in the public grounds, twenty-eight thousand dollars.

Watchmen. For day watchman in Franklin Square, six hundred and sixty dollars.

For day watchman in Lafayette Square, six hundred and sixty dollars.

For two day watchmen in Smithsonian Grounds, at six hundred and sixty dollars each, one thousand three hundred and twenty dollars.

For two night watchmen in Smithsonian Grounds, at seven hundred and twenty dollars each, one thousand four hundred and forty dollars.

For one day watchman at Judiciary Square and one at Lincoln Square and adjacent reservations, at six hundred and sixty dollars each, one thousand three hundred and twenty dollars.

For one night watchman at Judiciary Square, seven hundred and twenty dollars.

For one day watchman at Iowa Circle; one at Thomas Circle and neighboring reservations; one at Washington Circle and neighboring reservations; one at Dupont Circle and neighboring reservations; one at McPherson and Farragut squares; one at Stanton Square and neighboring reservations; two at Henry and Seaton squares and reservations east of Botanic Garden; one at Mount Vernon Square and adjacent reservations; one for the greenhouses and nursery; one at grounds south of Executive Mansion, eleven in all, at six hundred and sixty dollars each, seven thousand two hundred and sixty dollars.

For one night watchman at Henry and Seaton squares and reservations east of Botanic Garden, seven hundred and twenty dollars.

For one night watchman at Garfield Park, seven hundred and twenty dollars.

For contingent and incidental expenses, five hundred dollars. Contingent expenses.

* * * * * * *

Approved, July 31, 1894.

CHAP. 178.—An Act Making appropriations for fortifications and other works of defense, for the armament thereof, for the procurement of heavy ordnance for trial and service, and for other purposes. August 1, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the sums of money herein provided for be, and the same are hereby, appropriated, out of any moneys in the Treasury not otherwise appropriated, to be available until expended, namely: Fortifications appropriations.

GUN AND MORTAR BATTERIES: For construction of gun and mortar batteries, four hundred thousand dollars. Gun and mortar batteries.

For construction of gun and mortar platforms, one hundred thousand dollars.

SITES FOR FORTIFICATIONS AND SEACOAST DEFENSES: For the procurement of land, or right pertaining thereto, needed for the site, location, construction, or prosecution of works for fortifications and coast defenses, one hundred and fifty thousand dollars, or so much thereof as may be necessary. Sites.

PRESERVATION AND REPAIR OF FORTIFICATIONS: For the protection, preservation, and repair of fortifications for which there may be no special appropriation available, forty-five thousand dollars. Preservation, etc.

For construction of a sea-wall on the north shore of Sandy Hook, New Jersey, seven thousand five hundred dollars.

For preparation of plans for fortifications, five thousand dollars. Plans

SEWERAGE SYSTEM AT FORT MONROE, VIRGINIA: For one-half of the cost of construction of a sewerage system for all buildings at Fort Monroe, Virginia, thirty-seven thousand five hundred dollars: *Provided,* That the owners of hotels and of other nonmilitary buildings now at Fort Monroe, Virginia, shall bear one-half of the expense of construction of the said sewer, and the Secretary of War be, and he is hereby, authorized and directed to equitably and justly apportion among, assess against, and collect from the said owners and to expend in construction of the said sewer the moiety of the estimated cost thereof; and the Secretary of War is hereby further authorized to assess upon vessels using the wharf at Fort Monroe, Virginia, one-half of the actual cost of repairs rendered necessary by the ordinary wear and tear of said wharf, and any damage done to said wharf by any vessel shall be paid for by the owner or owners of said vessel; and he is also authorized and directed from time to time to cause to be assessed upon and collected from the owners of nonmilitary buildings situated Fort Monroe, Va. Sewerage. Provisos. Half to be paid by hotel owners, etc. Charges for wharfage. Charges for street repairs, etc.

within the limits of the Fort Monroe military reservation, and from individuals or corporations engaged in business thereat, other than water navigation companies, one-half of such sum or sums of money as he may deem just, reasonable, and necessary for expenditure upon the repair and operation of such roads, pavements, streets, lights, sewerage, and general police as, in the opinion of the Secretary of War, should be constructed and maintained in order to protect the interests of the United States and the interests, health, and general welfare of the said nonmilitary interests now established or that may hereafter be established

Use of receipts.

at Fort Monroe: *Provided further*, That all funds collected as above provided, or that may be received from other incidental sources from and after this date, be, and are hereby, made special contingent funds, to be collected and expended for the above purposes in accordance with rules and regulations to be prescribed by the Secretary of War, who will render annually to Congress a detailed account of all receipts and expenditures.

Balance covered in.
Vol. 25, p. 966.

And any unexpended balance of the appropriation for construction, complete, of a sewerage system at Fort Monroe, made by the sundry civil appropriation Act approved March second, eighteen hundred and eighty-nine, is hereby covered into the Treasury.

* * * * * * *

Purchases, tests, etc.

BOARD OF ORDNANCE AND FORTIFICATION: To enable the Board to make all needful and proper purchases, experiments, and tests to ascertain, with a view to their utilization by the Government, the most effective guns, small arms, cartridges, projectiles, fuses, explosives, torpedoes, armor plates, and other implements and engines of war, and to purchase or cause to be manufactured under authority of the Secretary of War, such guns, carriages, armor plates, and other war materials and articles as may, in the judgment of the Board, be necessary in the proper discharge of the duty devolved upon it by the Act approved September twenty-second, eighteen hundred and eighty-eight; to pay the salary of the civilian member of the Board of Ordnance and Fortification provided by the Act of February twenty-fourth, eighteen hundred and ninety-one, and for the necessary traveling expenses of said member when traveling on duty as contemplated in said Act; for payment of the necessary expenses of the Board, including a per diem allowance to each officer detailed to serve thereon when employed on duty away from his permanent station, of two dollars and fifty cents a day; and for the test of experimental guns and carriages procured in accordance with the recommendations of the Board of Ordnance and Fortification, one hundred thousand dollars. *Provided*, That before any money shall be expended in the construction or test of any gun, gun carriage, ammunition, or implements under the supervision of the said Board, the Board shall be satisfied, after due inquiry, that the Government of the United States has a lawful right to use the inventions involved in the construction of such gun, gun carriage, ammunition, or implements, or that the

Vol. 25, p. 489.
Civilian member.
Vol. 26, p. 769.
Expenses.
Proviso.
Right to use inventions.

construction or test is made at the request of a person either having such lawful right or authorized to convey the same to the Government.

That all material purchased under the foregoing provisions of this act shall be of American manufacture, except in cases when, in the judgment of the Secretary of War, it is to the manifest interest of the United States to make purchases in limited quantities abroad, which material shall be admitted free of duty. Purchases to be of American manufacture. Exception.

Approved August 1, 1894.

CHAP. 195.—An Act To amend an Act entitled "An Act authorizing the construction of a high wagon bridge across the Missouri River at or near Sioux City, Iowa," approved March second, eighteen hundred and eighty-nine, as amended by Acts of April thirtieth, eighteen hundred and ninety, February seventh, eighteen hundred and ninety-three, and March twenty-fourth, eighteen hundred and ninety-four. August 3, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section one of the Act entitled "An Act authorizing the construction of a high wagon bridge across the Missouri River at or near Sioux City, Iowa," approved March second, eighteen hundred and eighty-nine, as amended by an Act entitled "An Act to amend 'An Act authorizing the construction of a high wagon bridge across the Missouri River at or near Sioux City, Iowa, approved March second, eighteen hundred and eighty-nine,'" which amendment was approved April thirtieth, eighteen hundred and ninety, and as amended by an Act entitled "An Act to amend 'An Act authorizing the construction of a high wagon bridge across the Missouri River at or near Sioux City, Iowa, and so forth,'" which amendment was approved February seventh, eighteen hundred and ninety-three, and as amended by an Act entitled "An Act to amend 'An Act authorizing the construction of a high wagon bridge across the Missouri River at or near Sioux City, Iowa, approved March second, eighteen hundred and eighty-nine, as amended by Acts of April thirtieth, eighteen hundred and ninety, and February seventh, eighteen hundred and ninety-three,'" which amendment was approved March twenty-fourth, eighteen hundred and ninety-four, be so amended that instead and in place of the words "for such reasonable rates of toll as the city of Sioux City, Iowa, may from time to time prescribe, subject to the approval of the Secretary of War," the said section shall read "for such reasonable rates of toll as the owner or owners of said bridge may from time to time prescribe, subject to the approval of the Secretary of War."

Bridge across Missouri River at Sioux City, Iowa.

Vol. 25, p. 849.

Vol. 26, p. 79

Vol. 27, p. 434.

Toll to be approved by Secretary of War.

Approved, August 3, 1894.

August 4 1894.

CHAP. 206.—An Act Authorizing the Purcell Bridge and Transfer Company to construct and maintain a bridge over the South Canadian River at or within one mile of the town of Lexington, county of Cleveland, Territory of Oklahoma.

Purcell Bridge and Transfer Company may bridge South Canadian River, Lexington, Okla.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Purcell Bridge and Transfer Company, a corporation created under the laws of the Territory of Oklahoma by charter filed January fifteenth, anno Domini eighteen hundred and ninety-two, is authorized to construct and maintain a bridge, and approaches thereto, over the South Canadian River, at or within one mile of the town of Lexington, in the county of Cleveland, Territory of Oklahoma, to be used for the passage of foot passengers, animals, and vehicles of all kinds, for reasonable rates of tolls, to be approved from time to time by the Secretary of War.

Foot and wagon bridge.
Tolls.

Commencement and completion.

SEC. 2. That the right herein granted shall be void unless said bridge is commenced within one year and completed within three years from the passage of this act.

Lawful structure and post route.

SEC. 3. That the bridge constructed under this act shall be a lawful structure, and shall be known and recognized as a post route, and the same is hereby declared to be a post route upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than other persons pay for like transportation; and the United States shall have the right of way for the postal telegraph across said bridge: *Provided*, That before the construction of the bridge herein authorized is commenced the said company shall submit to the Secretary of War the plans and specifications of said bridge, showing the proposed location and structure contemplated, and that it shall be decided by the Secretary that said bridge does not and will not obstruct or impair the navigation of said South Canadian River: *Provided also*, That said bridge shall, at all times, be so kept and managed as to offer reasonable and proper means for the passage of vessels and other water craft through or under said structure, and for the safety of vessels passing at night there shall be displayed on said bridge, from the hours of sunset to sunrise, such lights or other signals as may be prescribed by the Light-House Board: *Provided further*, That Congress reserves the right to alter, amend, or repeal this act at any time: and that if at any time navigation of said river shall in any manner be obstructed or impaired by said bridge, the Secretary of War shall have authority, and it shall be his duty, to require the said company to alter and change the said bridge, at its own expense, in such manner as may be proper to secure free and complete navigation without impediment: and if upon reasonable notice to said company to make such change or improvements the said company fails to do so, the Secretary of War shall have authority to make the same at the expense of said company, and all rights conferred by this act shall be forfeited: and Congress shall have power to do any and all things necessary to secure the free navigation of said river.

Postal telegraph.
Provisos.
Secretary of War to approve plans etc.
Aids to navigation.
Lights, etc.
Amendments, etc.
Change.
Free navigation.

Approved, August 4, 1894.

August 4, 1894.

CHAP. 212.—An Act To amend an Act to authorize the construction of a steel bridge over the Saint Louis River, between the States of Minnesota and Wisconsin.

Bridge across St. Louis River.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That sections two and three of said Act be amended so as to read as follows:

Unobstructed navigation.

"SEC. 2. That any bridge built under the provisions of this Act shall be built and constructed without material interference with the security and convenience of navigation on said river beyond what is necessary to carry into effect the rights and privileges hereby granted, and shall be of such height in the clear above high-water mark as shall be prescribed by the Secretary of War, with rafting spans on either side of the draw of not less than two hundred and fifty feet each; and in order to secure compliance with these conditions the said corporation shall submit to the Secretary of War a plan of the bridge and accessory works provided for in this Act, together with a detailed map of the river for a distance of one mile above and one mile below the proposed site of said bridge, with such information as may be required by the Secretary of War for a full and satisfactory understanding of the subject; and the Secretary of War is hereby authorized and directed, upon receiving such plan and map and other information, and being satisfied that the bridge built upon such plan and with such accessory works and at such locality will conform to the prescribed condition of this Act, to notify the company that he approves the same; and upon receiving such notification the said company may proceed to the erection of said bridge, conforming strictly to the approved plan and location; but until the Secretary of War shall approve the plan and location of said bridge and accessory works, and notify the company of the same, the bridge shall not be built or commenced; and should any change be made or become necessary in the plan of the bridge or accessory works during the progress of construction or after completion such change shall likewise be subject to the approval and direction of the Secretary of War.

Height amended.

Secretary of War to approve plans, etc.

Changes.

Aids to navigation.

"SEC. 3. That the accessory works referred to in the preceding section shall be such booms, dikes, piers, or other suitable and proper structures for confining the flow of water to a permanent channel, and for the guiding of steamboats, rafts, and other water craft safely through the draw and rafting spans, as shall be required by the Secretary of War, and in addition thereto, and before the putting in place of the draw spans of the bridge to be built under this Act, the company or persons owning or holding such bridge shall be required, under the direction and supervision of the Secretary of War, or of such officer as he shall designate, to dredge out to a minimum depth of twenty-one feet, the two triangular spaces above and below the proposed site of the bridge, included in the interior angles formed by the crossing of the two ship channels at "the

Dredging.

Maintenance of basin omitted.

gate," to such an extent as to create a basin, the easterly and westerly limits of which shall be, respectively, at not less than one thousand feet from the axis of the bridge and shall be parallel thereto."

Approved, August 4, 1894.

August 6, 1894.

CHAP. 228.—An Act Making appropriations for the support of the Army for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, and for other purposes.

Army appropriations.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and they are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, for the support of the Army for the year ending June thirtieth, eighteen hundred and ninety-five:

* * * * * * *

MISCELLANEOUS.

* * * * * * *

Public buildings, etc., D. C.

For additional pay to officer in charge of public buildings and grounds in Washington, District of Columbia, one thousand dollars.

* * * * * * *

Incidental expenses.

Engineer depot at Willets Point, New York: Incidental expenses of the depot, including fuel, lights, chemicals, stationery, hardware; extra-duty pay to soldiers necessarily employed for periods not less than ten days as artificers on work in addition to and not strictly in line of their military duties, such as carpenters, blacksmiths, draftsmen, printers, lithographers, photographers, engine-drivers, teamsters, wheelwrights, masons, machinists, painters, overseers, laborers; repairs of and for materials to repair public buildings, machinery, and unforeseen expenses, four thousand dollars.

Materials.

For the purchase of materials for the instruction of engineer troops at Willets Point in their special duties as sappers and miners, for land and submarine mines, and pontoneers, torpedo drill, and signaling, three thousand five hundred dollars.

Instruments.

For purchase and repair of instruments to be issued to officers of the Corps of Engineers, and to officers detailed and on duty as acting engineer officers for use on public works and surveys, two thousand dollars.

Books.

Library of the United States Engineer School: Purchase and binding of professional works of recent date treating of military and civil engineering and kindred scientific subjects, five hundred dollars.

* * * * * * *

Approved, August 6, 1894.

CHAP. 231.—An Act To amend an Act approved January twenty-sixth, eighteen hundred and ninety-three, to authorize the construction of bridges across the Hiwassee, the Tennessee, and Clinch rivers, in the State of Tennessee.

August 7, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Act approved January twenty-sixth, eighteen hundred and ninety-three, entitled "An Act to authorize the construction of bridges across the Hiwassee, the Tennessee, and the Clinch rivers, in the State of Tennessee," be, and is hereby, amended so that the time within which the actual construction of said bridges may be commenced is hereby extended for the period of one year from the date of the approval of this Act.

Bridge across Hiwassee, Tennessee and Clinch rivers, Tenn.

Time for construction extended.

Vol. 27, p. 424.

Approved, August 7, 1894.

CHAP. 232.—An Act Making appropriations to provide for the expenses of the government of the District of Columbia for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, and for other purposes.

August 7, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the half of the following sums named, respectively, is hereby appropriated, out of any money in the Treasury not otherwise appropriated, and the other half out of the revenues of the District of Columbia, for the purposes following, being for the expenses of the government of the District of Columbia for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, namely:

District of Columbia appropriations.

Half from District revenues.

GENERAL EXPENSES.

General expenses

FOR SALARIES AND CONTINGENT EXPENSES.

Salaries, etc.

FOR EXECUTIVE OFFICE: * * * ; one Engineer Commissioner, one thousand seven hundred and sixty-eight dollars (to make salary five thousand dollars);

Executive office.

Engineer Commissioner.

* * * * * * *

FOR ENGINEER'S OFFICE: * * * *Provided,* That the last clause of section five of "An Act providing a permanent form of government for the District of Columbia," approved June eleventh, eighteen hundred and seventy-eight, is hereby amended so as to read as follows: The President of the United States may detail from the Engineer Corps of the Army not more than three officers, junior to the engineer officer belonging to the Board of Commissioners of said District, to act as assistants to said Engineer Commissioner in the discharge of the special duties imposed upon him by the provisions of this Act.

Proviso.

Engineer assistants.

Vol. 20, p. 107.

Three authorized.

* * * * * * *

CARE OF BRIDGES: * * * For the repair of the Aqueduct bridge, fifty-one thousand and seventy dollars,

Care of bridges. Aqueduct bridge.

said sum to be expended by, and the work to be done under the direction of, the Chief of Engineers of the Army, by contract or otherwise, and by the purchase of material in open market in order to prevent delay in the prosecution of the work.

Rock Creek Park. ROCK CREEK PARK: That the authorities in joint control of Rock Creek Park, as provided in section seven of the Act of September twenty-seventh, eighteen hundred and ninety, establishing said park, are authorized to rent or lease, for periods not exceeding one year at any one time, the buildings and arable ground therein, for such rental as shall seem proper to said authorities, and deposit the proceeds of such rents or leases with the collector of taxes to the credit of the United States and said District in equal parts.

Lease of buildings, etc., authorized.

* * * * * * *

Aqueduct.

WASHINGTON AQUEDUCT.

Engineering, etc. For engineering, maintenance, and general repairs, twenty thousand dollars.

Receiving reservoir. Towards the improvement of the receiving (or Dalecarlia) reservoir by the works required for cutting off the drainage into it of polluted water and sewage from the surrounding country; for the purchase or condemnation of the small amount of land required for the purpose, and the excavation necessary at the head of the reservoir, fifty-two thousand five hundred dollars, the work to be completed within the fiscal year eighteen hundred and ninety-five at a cost not to exceed ninety thousand dollars.

Conduit. For protecting the conduit at wasteweir numbered one, near Great Falls, five thousand dollars.

Bridges. For repaving Griffith's Park and Cabin John bridges, five thousand dollars.

* * * * * * *

Approved, August 7, 1894.

August 13, 1894. **CHAP. 280.**—An Act For the protection of persons furnishing materials and labor for the construction of public works.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That hereafter any person or persons entering into a formal contract with the United States for the construction of any public building, or the prosecution and completion of any public work or for repairs upon any public building or public work, shall be required before commencing such work to execute the usual penal bond, with good and sufficient sureties, with the additional obligations that such contractor or contractors shall promptly make payments to all persons supplying him or them labor and materials in the prosecution of the work provided for in such contract; and any person or persons making application therefor, and furnishing affidavit to the Department under the direction of which said work is being, or has been, prose-

Contractors on public works.

Penal bond to include security for labor and materials.

Action on bond for labor or materials furnished.

cuted, that labor or materials for the prosecution of such work has been supplied by him or them, and payment for which has not been made, shall be furnished with a certified copy of said contract and bond, upon which said person or persons supplying such labor and materials shall have a right of action, and shall be authorized to bring suit in the name of the United States for his or their use and benefit against said contractor and sureties and to prosecute the same to final judgment and execution: *Provided*, That such action and its prosecutions shall involve the United States in no expense.

Proviso. Expense

Costs.

SEC. 2. Provided that in such case the court in which such action is brought is authorized to require proper security for costs in case judgment is for the defendant.

Approved, August 13, 1894.

CHAP. 283.—An Act To authorize the construction of a wagon and foot bridge across the Chattahoochee River at or near the town of Columbia, Alabama.

August 13, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Columbia Bridge Company, a corporation created by or under the laws of the State of Alabama, its successors or assignees, be, and is hereby, authorized to construct, maintain, and operate a bridge for the passage of vehicles of all kinds, animals, and foot passengers, across the Chattahoochee River at or near the town of Columbia so as to connect with Georgia on the opposite shore: *Provided*, That any bridge built under the provisions of this Act may be built as a drawbridge, or with unbroken and continuous spans: *Provided also*, That if said bridge shall be built with unbroken and continuous spans, it shall give a clear headroom of not less than fifty-five feet above high-water mark as the same shall be fixed and determined by the Secretary of War: *And provided also*, That if said bridge shall be constructed as a drawbridge, the same shall be constructed as a pivot drawbridge, with a draw over the main channel of the river at an accessible and the best navigable point, and with drawspans giving a clear width of waterway of not less than one hundred feet on each side of the pivot pier; and said draw shall be opened promptly, upon reasonable signal, for the passage of boats: *Provided further*, That whatever kind of bridge is constructed the owners thereof shall maintain thereon, at their own expense, from sunset to sunrise, such lights or other signals as may be prescribed by the Light-House Board.

Columbia Bridge Company may bridge Chattahoochee River, Columbia, Ala.

Provisos. Construction.

High bridge.

Drawbridge.

Lights, etc.

SEC. 2. That any bridge built under the provisions of this Act shall be a lawful structure, and shall be recognized and known as a post route, upon which no higher charge shall be made for the transmission over the same of the mails, troops, and munitions of war of the United States passing over said bridge than the rate per mile paid for the transportation over the public highways leading to said bridge, and equal privileges in the use of said bridge shall be granted to all the telegraph and telephone com-

Lawful structure and post route.

panies; and the United States shall have the right of way across said bridge and approaches for postal-telegraph purposes; and said bridge shall be so constructed and operated as not to interfere with the navigation of said river.

Postal telegraph.

Free navigation.

SEC. 3. That said bridge company shall have the right to charge and collect a reasonable rate of toll, to be approved by the Secretary of War, not exceeding the rate limited by the law of Alabama.

Toll.

SEC. 4. That the bridge authorized to be constructed under this Act shall be located and built under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of the proposed bridge and a map of the location, giving for the space of one-half mile above and one-half mile below the proposed location the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the currents, and the soundings, accurately showing the bed of the stream, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge are approved by the Secretary of War no work upon the bridge shall be commenced, and should any change be made in the plan of said bridge during the progress of construction such change shall be subject to the approval of the Secretary of War.

Secretary of War to approve plans, etc.

Changes.

SEC. 5. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date of approval hereof.

Commencement and completion.

SEC. 6. That Congress hereby expressly reserves the right to alter, amend, or repeal this Act.

Amendment, etc.

Approved, August 13, 1894.

August 13, 1894.

CHAP. 285.—An Act To authorize a bridge across the Perdido River between the States of Florida and Alabama.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the county authorities of the counties of Escambia, Florida, and Baldwin, Alabama, be, and are hereby, authorized to construct, in accordance with plans to be approved by the Secretary of War, an iron or wooden bridge for free use by the public at or near Holman's Ferry across the Perdido River, between the States of Alabama and Florida, and to jointly maintain and regulate the same under such rules and regulations as may be agreed upon between the said counties.

Bridge authorized across Perdido River at Holman's Ferry, Fla. and Ala.

Free bridge.

SEC. 2. That said bridge shall be begun within one year and completed within three years from the date of the approval of this Act.

Commencement and completion.

SEC. 3. The right to alter, amend, or repeal this Act is hereby expressly reserved.

Amendment, etc.

Approved, August 13, 1894.

CHAP. 299.—An Act Making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes.

August 17, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums of money be, and are hereby, appropriated, to be paid out of any money in the Treasury not otherwise appropriated, to be immediately available, and to be expended under the direction of the Secretary of War and the supervision of the Chief of Engineers, for the construction, completion, repair, and preservation of the public works hereinafter named:

Appropriations for rivers and harbors.

Improving harbor at Camden, Maine: Continuing improvement, twelve thousand dollars.

Harbors. Camden, Me.

Improving harbor at Rockland, Maine: Continuing improvement, thirty thousand dollars, of which one thousand dollars may be expended in completing a survey of the same with a view of making it available for vessels of a deeper draft.

Rockland, Me.

Improving Mooseabec Bar, Maine: Continuing improvement, six thousand dollars.

Mooseabec Bar, Me.

Improving harbor at Back Cove, Portland Harbor, Maine: Continuing improvement, twenty thousand dollars.

Portland, Me Back Cove.

Improving harbor at Belfast, Maine: Continuing improvement, eight thousand dollars.

Belfast, Me.

For construction of breakwater from Mount Desert to Porcupine Island, Maine: Continuing improvement, ten thousand dollars, to be expended in accordance with the modified project recommended by the Secretary of War.

Mount Desert to Porcupine Island, Me., breakwater.

Improving harbor of refuge at Little Harbor, New Hampshire: Continuing improvement, ten thousand dollars.

Little Harbor, N. H.

Improving harbor at Burlington, Vermont: Continuing improvement, ten thousand dollars.

Burlington, Vt.

Improving harbor at Boston, Massachusetts: Continuing improvement, by deepening and widening the main channel to a depth of twenty-seven feet and a width of one thousand feet, two hundred thousand dollars, of which ten thousand dollars may, in the discretion of the Secretary of War, be used in the further prosecution of the work in Nantasket Beach channel.

Boston, Mass.

Improving harbor at Lynn, Massachusetts: Continuing improvement, seven thousand five hundred dollars: *Provided*, That the whole or any portion of this appropriation may be expended on the western channel, in the discretion of the Secretary of War.

Lynn, Mass. *Proviso.* Western channel.

Salem Harbor, Massachusetts: So much of the appropriation heretofore made, as may be necessary, shall be used in making a survey of Salem Harbor, with a view to widening the harbor channel to the mouth of South River to the width of five hundred feet, and giving a depth of at least ten feet at mean low water, and from the mouth of said river to Derby wharf, beginning with a width of three hundred feet and gradually narrowing, so that there shall be at said wharf a width of not less than one hundred and sixty feet and a depth from said mouth to said wharf of not less than ten feet at mean low water, and

Salem, Mass. Survey for widening channel. Vol. 27, p. 89.

with a view of dredging the "Middle Ground," so called, between "Haste Ledge" and "Aqua Vitae" so as to give a depth of twenty-five feet at mean low water.

Nantucket, Mass. Improving harbor of refuge at Nantucket, Massachusetts: Continuing improvement, twenty-five thousand dollars.

Newburyport, Mass. Improving harbor at Newburyport, Massachusetts: Continuing improvement, twenty thousand dollars.

Plymouth, Mass. Improving harbor at Plymouth, Massachusetts: Completing improvement, and for repairs, one thousand five hundred dollars.

Provincetown, Mass. For maintenance of works in harbor at Provincetown, Massachusetts, one thousand five hundred dollars.

Scituate, Mass. Improving harbor at Scituate, Massachusetts: Continuing improvement, ten thousand dollars.

Hyannis, Mass. Improving harbor at Hyannis, Massachusetts: Continuing improvement, three thousand five hundred dollars.

Vineyard Haven, Mass. Improving harbor at Vineyard Haven, Massachusetts: Continuing improvement, seven thousand five hundred dollars.

Sandy Bay, Cape Ann, Mass. Improving harbor of refuge at Sandy Bay, Cape Ann, Massachusetts: Continuing improvement, one hundred and fifty thousand dollars.

Gloucester, Mass. Improving harbor at Gloucester, Massachusetts: Continuing improvement, forty thousand dollars.

New Bedford, Mass. Improving harbor at New Bedford, Massachusetts: Completing improvement, seven thousand five hundred dollars, including survey with a view to obtaining a larger area of anchorage.

Wareham, Mass. Resurvey. Improving harbor at Wareham, Massachusetts: The Secretary of War is directed out of the appropriation on hand to make a resurvey of said harbor with a view to its further needed improvement.

Merrimac River. Resurvey. Merrimac River, Massachusetts: The Secretary of War is directed out of the appropriation on hand to make a re-survey of said river with a view of obtaining a depth up to Haverhill equal to that over the bar at Newburyport.

Marthas Vineyard, Mass. Improving inner harbor at Marthas Vineyard, Massachusetts: Completing improvement, two thousand five hundred dollars.

Canapitsit Channel, Mass. Improving Canapitsit Channel, Massachusetts, between the islands of Cuttyhunk and Neshawana: Completing improvement, five thousand dollars.

Block Island, R. I. Improving harbor at Block Island, Rhode Island: Completing improvement, two thousand five hundred dollars, including dredging when necessary and a survey and estimates of cost for further improvement of said harbor.

Newport, R. I. Improving harbor at Newport, Rhode Island, including the removal of Spindle Rock, Rose Island: Continuing improvement, seven thousand five hundred dollars.

Point Judith Pond, R. I. Entrance to Point Judith Pond, two thousand five hundred dollars, which, together with the previous unexpended appropriation, shall be used in improving former entrance to said pond.

Bridgeport, Conn. Improving harbor at Bridgeport, Connecticut: Continuing improvement, ten thousand dollars, of which, in the

discretion of the Secretary of War, so much as may be necessary may be used in deepening the channel at the outer bar, and in making a new survey of the harbor.

Black Rock, Conn.

Improving harbor at Black Rock, Connecticut: Continuing improvement, two thousand five hundred dollars.

New Haven, Conn., breakwaters.

Constructing breakwaters at New Haven, Connecticut: Continuing construction, one hundred and twenty-five thousand dollars.

Harbor.

Improving harbor at New Haven, Connecticut: Continuing improvement, ten thousand dollars.

Stonington, Conn.

Improving Stonington Harbor, Connecticut, by removing a part of Noyes' Shoal and dredging in the inner harbor, in accordance with the report of Captain W. H. Bixby, of the Corps of Engineers, dated June twelfth, eighteen hundred and ninety-three, five thousand dollars.

Five-Mile River, Conn.

Improving harbor at Five-Mile River, Connecticut: Continuing improvement, two thousand five hundred dollars.

Duck Island, Conn.

Improving harbor at Duck Island, on Long Island Sound, Connecticut: Continuing improvement, thirty thousand dollars.

Stamford, Conn.

Improving harbor at Stamford, Connecticut: Continuing improvement, ten thousand dollars, not less than half of which shall be expended on the East Branch.

Cos Cob and Mianus River, Conn.

Improving harbor at Cos Cob and Mianus River, Connecticut: Continuing improvement, four thousand dollars, including a survey of the lower part of the harbor with a view of making a turning basin therein.

Norwalk, Conn.

Improving Norwalk Harbor, Connecticut: Continuing improvement, fifteen thousand dollars. So much of this appropriation as may be necessary may, in the discretion of the Secretary of War, be expended between the freight depot of the Danbury and Norwalk Railroad Company on the north and Jennings, so called, on the south to remove the flats known as Ferrys Point between the channel and the established harbor line; and any unexpended balance, after completion of the above, may be used for the improvement of the sharp bend in the channel near Keysers Island at the mouth of the harbor: *Provided*, That the United States shall be subjected to no cost for any lands required to make this improvement.

Removing flats, etc.

Proviso. Expense.

Buffalo, N. Y.

Improving harbor at Buffalo, New York: Continuing improvement, seventy thousand dollars, of which five thousand dollars may be used in making a survey and plan for extending the outer breakwater from a point at or near the present outer breakwater southeasterly to a point at or near Stoney Point.

Canarsie Bay, N. Y.

Improving harbor at Canarsie Bay, New York: Continuing improvement, two thousand dollars.

Charlotte, N. Y.

Improving harbor at Charlotte, New York: Continuing improvement, fifteen thousand dollars.

Dunkirk, N. Y.

Improving harbor at Dunkirk, New York: Continuing improvement, twenty thousand dollars.

Flushing Bay, N. Y.

Improving harbor at Flushing Bay, New York: Continuing improvement, four thousand dollars.

Glen Cove, N. Y.

Improving harbor at Glen Cove, New York: Continuing improvement, ten thousand dollars.

New York Harbor.
Bay Ridge Channel.
Improving Bay Ridge and Red Hook channels, New York Harbor, New York: Continuing improvement of Bay Ridge Channel by dredging out and opening the same from a point at its junction with the Gowanus Creek Channel (near Twenty-eighth street), southerly therefrom along and in front of Gowanus Bay and Bay Ridge to a point where the said Bay Ridge Channel, so to be opened, encounters a twenty-six-foot contour or depth of water, so that the channel, so to be opened, shall be of a uniform depth of twenty-six feet and a width of eight hundred feet
Red Hook Channel.
at low water, and continuing improvement of Red Hook Channel from its junction with the Bay Ridge Channel to its connection with the Buttermilk Channel, to obtain a depth of twenty-six feet at mean low water and a width of four hundred feet, one hundred and fifty thousand dol-
Proviso.
lars: *Provided*, That the Secretary of War may, in his discretion, expend twenty thousand dollars of said appropria-
Gowanus Creek Channel.
tion in improving Gowanus Creek Channel under the project to obtain twenty-one feet depth of water.

Great Sodus Bay, N. Y.
Improving harbor at Great Sodus Bay, New York: Continuing improvement, fifteen thousand dollars.

Little Sodus Bay, N. Y.
Improving harbor at Little Sodus Bay, New York: Continuing improvement, eight thousand dollars.

Ogdensburg, N. Y.
Improving harbor at Ogdensburg, New York: Continuing improvement, twenty thousand dollars.

Oswego, N. Y.
Improving harbor at Oswego, New York: Continuing improvement, thirty-seven thousand dollars, of which ten thousand dollars shall be expended in repairing the breach recently made in the breakwater; and not exceeding ten thousand dollars of which may, in the discretion of the Secretary of War, be used for removing rock to widen and deepen the inner harbor near the mouth of the Oswego River.

Rondout, N. Y.
Improving harbor at Rondout, New York: For maintenance, five thousand dollars.

New York Harbor.
Improving New York Harbor, New York: Continuing improvement, seventy-five thousand dollars.

Saugerties, N. Y.
Improving harbor at Saugerties, New York: For completion, five thousand dollars.

Port Chester, N. Y.
Improving harbor at Port Chester, New York: Continuing improvement, five thousand dollars.

Tonawanda and Niagara River N. Y.
Improving Tonawanda Harbor and Niagara River, New York: Continuing improvement, fifty thousand dollars.

Niagara River.
Improving Niagara River from Tonawanda to Port Day with a view to obtaining a channel of twelve feet depth to Schlosser's Dock by cutting through the shoal at the head of Connor's Island as indicated in the report of the Chief of Engineers for eighteen hundred and ninety-three, page three thousand one hundred and thirteen, ten thousand
Balance reappropriated.
Vol 27, p. 97.
dollars; and the unexpended balance of the appropriation heretofore made in the River and Harbor Act of July thirteenth, eighteen hundred and ninety-two, for the improvement of the Niagara River from Tonawanda to Port Day is hereby re-appropriated for this purpose.

Staten Island and New Jersey channel.
Improving channel between Staten Island and the New Jersey shore, New York and New Jersey: Continuing improvement, six thousand dollars.

Improving Arthur Kill, between Staten Island and New Jersey shore, New York and New Jersey: For completion, four thousand five hundred dollars. Arthur Kill, N. Y.

Improving harbor at Huntington, New York: Continuing improvement, two thousand dollars. Huntington, N. Y.

Improving Buttermilk Channel, New York Harbor: Continuing improvement, fifty thousand dollars. Buttermilk Channel, N. Y.

Improving harbor at Port Jefferson Inlet, New York: Seven thousand five hundred dollars to be expended in obtaining twelve feet in depth at mean low water in Port Jefferson Inlet and Harbor, in accordance with the plan submitted in annual report of the Chief of Engineers for eighteen hundred and eighty-nine. Port Jefferson, N. Y.

Improving harbor at Pultneyville, New York: Continuing improvement, one thousand five hundred dollars. Pultneyville, N. Y.

Improving harbor at Sacketts Harbor, New York: For completion, five thousand dollars. Sacketts Harbor, N. Y.

Improving harbor at Raritan Bay, New Jersey: Continuing improvement, forty thousand dollars, one-half of which, in the discretion of the Secretary of War, shall be used in dredging bar between South Amboy and Great Beds Light. This appropriation shall include a survey between South Amboy and Great Beds Light, with a view to deepening the channel to twenty-one feet at mean low water. Raritan Bay, N. J.

Improving Keyport Harbor, New Jersey: Completing improvement, five thousand dollars. Keyport, N. J.

Improving harbor at Erie, Pennsylvania: Continuing improvement, ten thousand dollars. Erie, Pa.

Improving Delaware Breakwater, Delaware: Continuing improvement, fifty thousand dollars. Delaware Breakwater.

Improving harbor at Wilmington, and Christiana River, Delaware: Continuing improvement, twenty-five thousand dollars, including a survey of the Christiana River and harbor, with a view of obtaining a depth of twenty-one feet. Wilmington, Del.

Improving harbor at Baltimore, Maryland: For maintenance, fifty thousand dollars. Baltimore, Md.

Improving harbor at Norfolk and its approaches, Virginia: Continuing improvement, one hundred thousand dollars. Norfolk, Va.

Improving Harbor at Winyaw Bay, South Carolina: Continuing improvement, one hundred and ten thousand dollars. Winyaw Bay, S. C.

Harbor of Savannah, Georgia: The Secretary of War is hereby directed to report whether the works projected for the improvement of the harbor will, when completed, afford safe anchorage for vessels lying in Tybee Roads; if not, whether there is any necessity for so constructing them, giving, if so, such changes in plans and estimates as may be necessary. Savannah, Ga. Report on anchorage.

Improving harbor at Brunswick, Georgia: For maintenance, ten thousand dollars. Brunswick, Ga.

Improving the outer bar of Brunswick, Georgia, thirty thousand dollars, the whole of which shall be paid to C. P. Goodyear for depth of water heretofore obtained over said outer bar. And the Secretary of War is hereby authorized Outer bar. Payment to C. P. Goodyear. Vol. 27, p. 280.

to pay to said C. P. Goodyear, his heirs or assigns, upon procurement by the said Goodyear, his heirs or assigns, of a practical channel over said outer bar at Brunswick at least one hundred feet in width and of a minimum depth of twenty-three feet at ordinary mean high tide on or before November first, eighteen hundred and ninety-five, the sum of thirty thousand dollars; upon the procurement as aforesaid, on or before the first day of January, eighteen hundred and ninety-seven, of a depth of water in said channel over said outer bar of a minimum depth at ordinary mean high tide of twenty-four feet, and of said width, forty thousand dollars, to be paid in manner aforesaid; upon the procurement as aforesaid, on or before January first, eighteen hundred and ninety-eight, of a depth of water in said channel of a minimum depth at ordinary mean high tide of twenty-five feet, and of said width, fifty thousand dollars, to be paid in manner aforesaid. And should the depth of twenty-five feet at ordinary mean high tide in said channel over said outer bar be procured as aforesaid and maintained for two years thereafter for the width above named, twenty-five thousand dollars in addition shall be paid in manner aforesaid. The said C. P. Goodyear, his heirs and assigns, shall procure said work on said outer bar by the explosion of dynamite on the bottom of said channel or sunk beneath the bottom thereof, in his or their discretion, and not otherwise, and shall use the necessary auxiliary means for smoothing the bottom of the bar. The money necessary to carry out the provisions of this item is hereby appropriated out of any money in the Treasury not otherwise appropriated: *Provided*, That no payments except the first, of thirty thousand dollars, shall be made except upon a certificate of a majority of a board of officers, two of whom shall be officers of the Engineer Corps, detailed for that purpose by the Secretary of War, and the third shall be the Chief of the Coast and Geodetic Survey, that the said C. P. Goodyear, his heirs and assigns, have complied with all the conditions as to any of the depths and widths named or as to the maintenance of a depth of twenty-five feet accomplished in accordance with the provisions of this item.

Use of dynamite.

Proviso.
Certificate from officers.

Cumberland Sound, Ga.

Improving Cumberland Sound, Georgia: Continuing improvement, one hundred and seventy thousand dollars.

Darien, Ga.

Improving harbor at Darien, Georgia: Continuing improvement, twenty-five thousand dollars.

Apalachicola Bay, Fla.

Improving harbor at Apalachicola Bay and River, Florida: Continuing improvement, fifteen thousand dollars.

Pensacola Fla.

Improving harbor at Pensacola, Florida: Continuing improvement, one hundred thousand dollars; and the Secretary of War may, if he deems it advisable, begin the improvement recommended by the Board of Engineers appointed in January, eighteen hundred and ninety-one, to consider and report upon the improvement of said harbor.

Key West, Fla.

Improving entrance to harbor at Key West, Florida: Continuing improvement, eighty thousand dollars.

Saint Augustine, Fla.

Improving harbor at Saint Augustine, Florida: Continuing improvement, six thousand dollars.

Improving Charlotte Harbor and Pease Creek, Florida: Continuing improvement, twenty thousand dollars. Charlotte, Fla.

Harbor at Mobile, Alabama: The Secretary of War shall cause a survey to be made to ascertain the cost of widening the channel of said harbor now in course of improvement, to obtain a width of one hundred feet at the bottom, with a proper slope therefor, and also a survey to ascertain the best point for and the cost of a sufficient channel between Mobile Bay and the Mississippi Sound for the proper accommodation of commerce; and the expenses of said two surveys shall be paid out of any appropriation made for the improvement of the channel of Mobile Harbor. Mobile, Ala. Surveys. Payment.

The Secretary of War is authorized, at his discretion, to use not exceeding ten thousand dollars of the amount appropriated for the improvement of Mobile Harbor in keeping the channel clear of timber, logs and other obstructions. Clearing channel.

The Secretary of War is authorized, at his discretion, to use such amount as may be necessary, not to exceed fifty thousand dollars, of the amount appropriated for the improvement of Mobile Harbor by the sundry civil bill for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, in removing shoals and other obstructions in the Mobile and Tombigbee rivers, between the mouth of Chickasabogue Creek and Nannahubba Bluff, so as to secure a depth of sixteen feet at low water: *Provided*, That if a contract has been entered into for the improvement of said harbor, by the terms of which the amount to be so appropriated for said fiscal year should be paid to a contractor or contractors for work to be done by him or them, then no part of said appropriation shall be so diverted without the consent of such contractor or contractors. Removing obstructions from Mobile and Tombigbee rivers. *Proviso.* Terms of contract to be complied with.

Improving mouth and passes of Calcasieu River, Louisiana: Continuing improvement, ninety thousand dollars, of which fifteen thousand dollars, or so much thereof as may be necessary, shall be used on the inner bars. Calcasieu River, La.

Improving harbor at Vicksburg, Mississippi, not including work at Delta Point, Louisiana: Continuing improvement under the direction of the Secretary of War, forty thousand dollars. Vicksburg, Miss.

Improving and maintaining ship channel in Galveston Bay, Texas: Continuing improvement according to the existing project, fifty thousand dollars. Galveston Bay, Tex., ship channel.

Improving channel in West Galveston Bay, Texas: Continuing improvement according to existing project, five thousand dollars. West Galveston Bay, Tex.

Improving harbor at Sabine Pass, Texas: Continuing improvement, two hundred and seventy-five thousand dollars. Sabine Pass, Tex.

Improving harbor at Ashtabula, Ohio: Continuing improvement, seventy-five thousand dollars, including a survey to determine what improvement thereof should be made with a view to making it a harbor of refuge and enlarging its capacity for the purposes of commerce. Ashtabula, Ohio.

Improving harbor at the mouth of Black River, Ohio: Continuing improvement, ten thousand dollars. Black River, Ohio.

Cleveland, Ohio. Improving harbor at Cleveland, Ohio: Continuing improvement, fifty thousand dollars.

Fairport, Ohio. Improving harbor at Fairport, Ohio: Continuing improvement, twenty thousand dollars.

Huron, Ohio. Improving harbor at Huron, Ohio: Continuing improvement, ten thousand dollars.

Port Clinton, Ohio. Improving harbor at Port Clinton, Ohio: Continuing improvement, six thousand dollars.

Sandusky, Ohio. Improving harbor at Sandusky, Ohio: Continuing improvement, thirty thousand dollars, five thousand dollars of which may be used in removing shoal at outer approach to harbor; and the Secretary of War is authorized and directed, in his discretion, to cause a survey, if necessary for the purpose, and an estimate to be made of the cost of further necessary improvement of said harbor, including the channel over said outer bar.

Toledo, Ohio. Improving harbor at Toledo, straight channel through Maumee Bay, Ohio: Continuing improvement, seventy thousand dollars, a part of which may be used, in the discretion of the Secretary of War, in removing shoal in the old channel and in extending the improvement up the Maumee River.

Conneaut, Ohio. Improving Conneaut Harbor, Ohio: Continuing improvement according to the existing plan, forty thousand dollars.

Vermillion, Ohio. Improving harbor at Vermillion, Ohio: For maintenance and repairs, two thousand dollars.

Michigan City, Ind. Improving outer harbor at Michigan City, Indiana: Continuing improvement, twenty thousand dollars.

Improving inner harbor at Michigan City, Indiana: Continuing improvement, ten thousand dollars.

Calumet, Ill. Improving Calumet Harbor, Illinois: For maintenance of existing works, fifteen thousand dollars, including survey with a view to such additional improvement as may be required.

Chicago, Ill. Improving harbor at Chicago, Illinois: Completing improvement, eighty thousand dollars; and the Secretary of War may, in his discretion, use twenty-five thousand dollars of this sum in the improvement of Chicago River up to the forks of said river.

Waukegan, Ill. Improving harbor at Waukegan, Illinois: Continuing improvement, twenty thousand dollars.

Charlevoix, Mich. Improving harbor at Charlevoix and entrance to Pine Lake, Michigan: Continuing improvement, eight thousand dollars.

Frankfort, Mich. Improving harbor at Frankfort, Michigan: Continuing improvement, and repairs, fifty thousand dollars.

Grand Haven, Mich. Improving harbor at Grand Haven, Michigan: Continuing improvement, twenty-five thousand dollars.

Grand Marais, Mich. Improving harbor of refuge at Grand Marais, Michigan: Continuing improvement, twenty thousand dollars.

Manistee, Mich. Improving harbor at Manistee, Michigan: Continuing improvements, and for repairs, twelve thousand dollars:

Proviso. Protecting banks, etc. *Provided*, That no part of this sum shall be used in aid of the inner navigation until the city authorities, or private owners, have taken proper steps to prevent erosion of the banks and the washing of silt into the bed of the river.

Improving harbor at Holland (Black Lake), Michigan: Completing improvement, fifteen thousand dollars. Holland, Mich.

Improving harbor at Monroe, Michigan: Continuing improvement, and maintenance, five thousand dollars. Monroe, Mich.

Improving harbor at Muskegon, Michigan: Continuing improvement, thirty thousand dollars. Muskegon, Mich.

Improving harbor at Ontonagon, Michigan: Continuing improvement, and for repairs, seven thousand dollars. Ontonagon, Mich.

Improving harbor at Pentwater, Michigan: Continuing improvement, five thousand dollars. Pentwater, Mich.

Improving harbor at Sand Beach, Michigan: Continuing improvement according to the existing project, twenty thousand dollars. Sand Beach, Mich.

Improving harbor at Portage Lake, Michigan: Continuing improvement, twenty-five thousand dollars. Portage Lake, Mich.

Improving harbor at Saint Joseph, Michigan: Continuing improvement, thirty thousand dollars. Saint Joseph, Mich.

Improving harbor at South Haven, Michigan: Continuing improvement, twenty thousand dollars. South Haven, Mich.

Improving harbor at White Lake, Michigan: Continuing improvement, five thousand dollars. White Lake, Mich.

Improving harbor at Marquette, Michigan: Continuing improvement, thirty thousand dollars. Marquette, Mich.

Improving harbor at Ludington, Michigan: Continuing improvement, six thousand dollars. Ludington, Mich.

Improving harbor at Petoskey, Michigan: Ten thousand dollars, to be expended together with the unexpended appropriations for this harbor, according to the larger of the two projects submitted in the report of December twenty-first, eighteen hundred and eighty-nine, and printed in the annual report for eighteen hundred and ninety, pages twenty-six hundred and seventy-four and twenty-six hundred and seventy-five. Petoskey, Mich. Vol. 27, p. 94.

Improving harbor at Saugatuck, Michigan: Continuing improvement and for restraining works to prevent the drifting of sand into the harbor, twelve thousand dollars. Saugatuck, Mich.

Improving harbor at Menominee, Michigan and Wisconsin: Continuing improvement, ten thousand dollars. Menominee, Mich. and Wis.

Improving Cheboygan Harbor, Michigan: The Secretary of War is hereby directed to expend the unexpended balance on hand in dredging. He is also directed to make an estimate of the amount required to deepen the present channel to a depth of eighteen feet. Cheboygan, Mich. Dredging. Vol. 25, p. 405.

Improving harbor at Ahnapee, Wisconsin: Continuing improvement, five thousand dollars. Ahnapee, Wis.

Improving harbor at Green Bay, Wisconsin: Continuing improvement, twenty-five thousand dollars. Green Bay, Wis.

Improving harbor at Kenosha, Wisconsin: Continuing improvement, fifteen thousand dollars. Kenosha, Wis.

Improving harbor at Kewaunee, Wisconsin: Continuing improvement, twenty thousand dollars. Kewaunee, Wis.

Improving harbor at Manitowoc, Wisconsin: Continuing improvement and maintenance, twenty thousand dollars. Manitowoc, Wis.

Improving harbor of refuge at Milwaukee, Wisconsin: Continuing improvement, forty-five thousand dollars. Milwaukee, Wis. Harbor of refuge.

Repairs, etc. Improving harbor at Milwaukee, Wisconsin: For repairs of piers and dredging, seven thousand dollars, and including survey of the harbor at South Milwaukee with a view to the improvement thereof.

Port Washington, Wis. Improving harbor at Port Washington, Wisconsin: Continuing improvement, five thousand dollars.

Racine, Wis. Improving harbor at Racine, Wisconsin: Continuing improvement, twenty thousand dollars.

Superior and Saint Louis bays, Wis. Improving harbor at Superior Bay and Saint Louis Bay, Wisconsin: Continuing improvement, fifty thousand dollars, a portion of which may, in the discretion of the Secretary of War, be used in dredging in Superior Bay along the dock line between the Quebec channel and the main channel opposite the base of Connor's Point: *Proviso.* *Survey.* *Provided*, That so much of said sum as may be necessary may be used for the purpose of making a survey of said harbor with a view of deepening it to twenty feet and making estimates therefor.

Sheboygan, Wis. Improving harbor at Sheboygan, Wisconsin: Continuing improvement, twenty-five thousand dollars, of which the sum of four hundred and thirty-nine dollars and fifty-six cents may be paid by the Secretary of War to the C. Dredging. Reiss Coal Company, of Sheboygan, Wisconsin, for dredging done by them in the harbor.

Ashland, Wis. Improving harbor at Ashland, Wisconsin: Continuing improvement, twenty-five thousand dollars.

Two Rivers, Wis. Improving harbor at Two Rivers, Wisconsin: Continuing improvement, three thousand dollars.

Sturgeon Bay, Wis. Improving harbor of refuge at Sturgeon Bay Canal, Wisconsin: For maintenance of channel and piers, five thousand dollars.

Oconto, Wis. Improving harbor at Oconto, Wisconsin: To maintain *Proviso.* Survey, etc. works, three thousand dollars: *Provided*, That so much of said sum as may be necessary may be used for the purpose of making a survey and submitting plans and estimates for the improvement and confinement of the current in the river to maintain a standard depth of water, and to obtain a channel sixteen feet deep, and for extending the piers and for the construction of a harbor sixteen feet deep in Green Bay exterior to the river channel.

Duluth, Minn. Improving harbor at Duluth, Minnesota, including repairs to the canal, piers, the channel on the north shore of Saint Louis Bay and the Saint Louis River, seventy-five thousand dollars, of which an amount not to exceed twenty-five thousand dollars, in the discretion of the Secretary of War, may be expended in the channel of Saint Louis River *Proviso.* Survey. above Grassy Point: *Provided*, That so much of said sum as may be necessary may be used for the purpose of making a survey of said harbor with a view of deepening it to twenty feet and making estimates therefor. The Secretary of War is authorized to negotiate with the city of Duluth Donation of lands from city. for the unconditional donation of the land needed for said canal, canal entrances, and piers, accompanied by vacation of the abutting streets. In the event the city refuses to make an unconditional donation, but accompanies the donation with the reservation of a right of way for a tun-

nel, the Secretary of War may accept such conditional donation of the land; provided the said tunnel follows such lines and grades as he may approve.

Improving harbor at Grand Marais, Minnesota: Continuing improvement, three thousand dollars. Grand Marais, Minn.

Improving harbor at Agate Bay, Minnesota: Continuing improvement, thirty thousand dollars. Agate Bay, Minn.

Improving harbor at Oakland, California: Continuing improvement, one hundred thousand dollars, of which twelve thousand dollars, or so much thereof as may be necessary, shall be used in opening the western end of the tidal canal in said harbor to the depth of eight feet below low tide. Oakland, Cal.

Improving harbor at San Diego, California: Continuing improvement, fifty thousand dollars. San Diego, Cal.

Improving harbor at San Luis Obispo, California: Continuing improvement, forty thousand dollars. San Luis Obispo, Cal.

Improving entrance and harbor at Coos Bay, Oregon: Continuing improvement, ninety-five thousand dollars; and for the construction or purchase of a dredger, and operating the same in removing obstructions from and deepening the harbor of Coos Bay in front of Marshfield, thirteen thousand dollars. Coos Bay, Oreg.

Improving harbor at Yaquina Bay, Oregon: Continuing improvement, fifty thousand dollars. Yaquina Bay, Oreg.

Improving Tillamook Bay, Oregon: Continuing improvement, sixteen thousand dollars. Tillamook Bay, Oreg.

Improving Grays Harbor and Chehalis River, Washington: Continuing improvement, twenty-five thousand dollars. Grays Harbor, Chehalis River, Wash.

Improving Olympia Harbor, Washington: Continuing improvement, forty thousand dollars. Olympia, Wash.

Improving Bagaduce River, Maine: Continuing improvement, five thousand dollars. Rivers. Bagaduce River, Me.

Improving Lubec Channel, Maine: Continuing improvement according to plan submitted by Colonel J. A. Smith, December thirtieth, eighteen hundred and ninety, five thousand dollars; and the Secretary of War is hereby authorized, in his discretion, to expend on this improvement any unexpended balance of appropriations hitherto made for the improvement of the Saint Croix River. Lubec Channel, Me.

Improving Kennebec River, Maine: Continuing improvement, fifty thousand dollars. Kennebec River, Me.

Improving Narragaugus River, Maine: Continuing improvement, five thousand dollars. Narragaugus River, Me.

Harraseeket River, Maine: To complete improvement, five thousand dollars. Harraseeket River, Me.

Improving Saco River, Maine, including breakwater: Continuing improvement, ten thousand dollars. Saco River, Me.

Improving Bellamy River, New Hampshire: Continuing improvement, seven thousand five hundred dollars. Bellamy River, N. H.

Improving Cocheco River, New Hampshire: Continuing improvement, fifteen thousand dollars. Cocheco River, N. H.

Improving Otter Creek, Vermont: Continuing improvement, five thousand dollars. Otter Creek, Vt.

Powow River, Mass.

Improving Powow River, Massachusetts: Continuing improvement, fifteen thousand dollars.

Taunton River, Mass.

Improving Taunton River, Massachusetts: Continuing improvement, five thousand dollars.

Weymouth River, Mass.

Improving Weymouth River, Massachusetts: Continuing improvement, five thousand dollars, of which two thousand five hundred dollars shall be used in the improvement of Weymouth Back River.

Essex River, Mass.

Improving Essex River, Massachusetts: Continuing improvement, five thousand dollars.

Mystic and Malden rivers, Mass.

Improving Mystic and Malden rivers, Massachusetts: Continuing improvement, ten thousand dollars.

Pawtucket River, R. I.

Improving Pawtucket River, Rhode Island: Continuing improvement, twenty-five thousand dollars.

Pawcatuck River, R. I. and Conn.

Improving Pawcatuck River, Rhode Island and Connecticut: Continuing improvement according to original plan for excavation of channel to a width of forty feet between the lower and upper wharves in the town of Westerly, and continuing the excavation of the channel to the full width of one hundred feet, six thousand dollars.

Providence River, Narragansett Bay, R. I.

Improving Providence River and Narragansett Bay, Rhode Island: Continuing improvement, seventeen thousand five hundred dollars.

Green Jacket Shoal, R. I.

Improving Green Jacket Shoal, Providence, Rhode Island: Continuing improvement, seven thousand five hundred dollars.

Connecticut River, Conn.

Improving Connecticut River below Hartford, Connecticut: Continuing improvement, twenty thousand dollars.

Housatonic River, Conn.

Improving Housatonic River, Connecticut: Continuing improvement, twenty-five thousand dollars.

Thames River, Conn.

Improving Thames River, Connecticut: Continuing improvement, twelve thousand five hundred dollars.

Mystic River, Conn.

Improving Mystic River, Connecticut: Continuing improvement, three thousand five hundred dollars.

Saugatuck River, Conn.

Improving Saugatuck River, Connecticut: For completion, three thousand dollars.

Newtown Creek, N. Y.

Improving Newtown Creek, New York: Continuing improvement, twenty thousand dollars.

Harlem River, N. Y.

Improving Harlem River, New York: Continuing improvement, one hundred and twenty-five thousand dollars.

East River and Hell Gate, N. Y.

Improving East River and Hell Gate, New York: Continuing improvement, seventy-five thousand dollars.

Browns Creek, N. Y.

Improving Browns Creek, Sayville, Long Island, New York: For maintenance, four thousand dollars.

East Chester Creek, N. Y.

Improving East Chester Creek, New York: Continuing improvement, twelve thousand dollars.

Great Chazy River, N. Y.

Improving Great Chazy River, New York: For completion, three thousand dollars.

Patchogue River, N. Y.

Improving Patchogue River, New York: Continuing improvement, four thousand dollars.

Saint Lawrence River, N. Y.

Improving shoal between Sister Islands and Cross-Over Light, Saint Lawrence River, New York: Continuing improvement, eight thousand dollars, to be expended for improving shoals between Sister Islands and Cross-Over

Improving Potomac River, Washington, District of Columbia: Continuing improvement, one hundred and fifty thousand dollars. Potomac River, D. C.

Improving Appomattox River, Virginia: Continuing improvement, five thousand dollars. Appomattox River, Va.

Improving Nansemond River, Virginia: Continuing improvement, ten thousand dollars, including survey and preparing estimate for the improvement of Nandua creek. Nansemond River, Va.

Improving James River, Virginia: Continuing improvement, one hundred thousand dollars. James River, Va.

Improving Mattaponi River, Virginia: Continuing improvement, four thousand dollars, of which one thousand five hundred dollars shall be expended between Aylett's and Guinea's bridges. Mattaponi River, Va.

Improving Nomini Creek, Virginia: Continuing improvement, five thousand dollars. Nomini Creek, Va.

Improving Pamunkey River, Virginia: Continuing improvement, two thousand dollars. Pamunkey River, Va.

Improving Rappahannock River, Virginia: Continuing improvement, ten thousand dollars. Rappahannock River, Va.

Improving Urbanna Creek, Virginia: Continuing improvement, three thousand dollars. Urbanna Creek, Va.

Improving York River, Virginia: Continuing improvement, twenty thousand dollars. York River, Va.

Improving Aquia Creek, Virginia: Continuing improvement, three thousand dollars. Aquia Creek, Va.

Improving Occoquan Creek, Virginia: Continuing improvement, five thousand dollars. Occoquan Creek, Va.

Protecting Jamestown Island from the encroachments of James River, ten thousand dollars, or so much thereof as may be necessary. James River, Jamestown Island, Va.

Improving Lower Machodoc Creek, Virginia: Continuing improvement, three thousand dollars. Lower Machodoc Creek, Va.

Improving Elk River, West Virginia: Continuing improvement, two thousand dollars. Elk River, W. Va.

Improving Guyandotte River, West Virginia: For maintenance, two thousand dollars. Guyandotte River, W. Va.

Improving Gauley River, West Virginia: Continuing improvement, three thousand dollars. Gauley River, W. Va.

Improving Roanoke River, North Carolina: Continuing improvement, thirty thousand dollars. Roanoke River, N. C.

Improving inland waterway between Beaufort Harbor and New River, North Carolina: Continuing improvement, two thousand five hundred dollars. Waterway, Beaufort to New River, N. C.

Improving Trent River, North Carolina: Continuing improvement, four thousand dollars. Trent River, N. C.

Improving North East (Cape Fear) River, North Carolina: Continuing improvement, five thousand dollars. North East River, N. C.

Improving Pasquotank River, North Carolina: Completing improvement, one thousand dollars. Pasquotank River, N. C.

Improving Cape Fear River, North Carolina, above Wilmington: Continuing improvement, fourteen thousand dollars. Cape Fear River, N. C., above Wilmington.

Improving Cape Fear River, North Carolina, from Wilmington to its mouth: Continuing improvement, two hundred thousand dollars. Below Wilmington.

Smyrna River, Del.

Improving Smyrna River, Delaware: Continuing improvement, five thousand dollars.

Murderkill River, Del.

Improving Murderkill River, Delaware: Continuing improvement, six thousand five hundred dollars, of which one thousand five hundred dollars, in the discretion of the Secretary of War, may be used in removing the bar and obstructions at the mouth of Saint Jones River.

Mispillion River, Del.

Improving Mispillion River, Delaware: Continuing improvement, ten thousand dollars.

Waterway, Chincoteague and Delaware bays.

Improving the inland waterway from Chincoteague Bay, Virginia, to Delaware Bay, at or near Lewes, Delaware, to be used from Delaware Bay to Indian River: Continuing improvement, twenty-five thousand dollars.

Broad Creek River, Del.

Improving Broad Creek River, Delaware: Continuing improvement, five thousand dollars, of which so much as may be necessary shall be used for removal of bar that extends from the railroad bridge at Seaford toward the mouth of Nanticoke River.

Choptank River, Md.

Improving Choptank River, Maryland: Continuing improvement, two thousand dollars.

Susquehanna River, Md. and Pa.

Improving Susquehanna River, Maryland and Pennsylvania: For maintenance, four thousand dollars, to be expended above Havre de Grace, including survey from a point one mile below the town of Havre de Grace to a point one mile above Port Deposit, to ascertain what is necessary to prevent the accumulation of ice and ice gorges in said river and the cost thereof.

Chester River, Md.

Improving Chester River, Maryland: Continuing improvement, one thousand five hundred dollars.

Manokin River, Md.

Improving Manokin River, Maryland: Continuing improvement, four thousand dollars.

Wicomico River, Md.

Improving Wicomico River, Maryland: Continuing improvement, three thousand dollars.

La Trappe River, Md.

Improving La Trappe River, Maryland: Completing improvement, four thousand seven hundred and fifty dollars.

Warwick River, Md.

Improving Warwick River, Maryland: Continuing improvement, two thousand dollars.

Patapsco River, Md.

Improving Patapsco River and channel to Baltimore: Continuing improvement from main ship channel to Curtis Bay, twelve thousand dollars.

Delaware and Chesapeake Canal.

That the President of the United States is hereby authorized to appoint a board, to consist of an officer of the Engineer Corps of the United States Army, not below the rank of lieutenant-colonel, an officer of the United States Navy, not below the rank of captain, and two civilians, who, together with the Chief of the Engineers of the United States Army, shall examine and determine, from the surveys heretofore made under the direction of the War Department, the most feasible route for the construction of the Chesapeake and Delaware Canal. And in making such

Board to select route, etc.

selection said board shall select a route which in its judgment shall give the greatest facility to commerce and will be best adapted for national defense. The said board shall

Report.

report its conclusions to the Secretary of War, who shall transmit the same to Congress at its next session; and the sum of five thousand dollars is hereby appropriated to pay the expenses of the said board.

Potomac River, D. C.

Improving Potomac River, Washington, District of Columbia: Continuing improvement, one hundred and fifty thousand dollars.

Appomattox River, Va.

Improving Appomattox River, Virginia: Continuing improvement, five thousand dollars.

Nansemond River, Va.

Improving Nansemond River, Virginia: Continuing improvement, ten thousand dollars, including survey and preparing estimate for the improvement of Nandua creek.

James River, Va.

Improving James River, Virginia: Continuing improvement, one hundred thousand dollars.

Mattaponi River, Va.

Improving Mattaponi River, Virginia: Continuing improvement, four thousand dollars, of which one thousand five hundred dollars shall be expended between Aylett's and Guinea's bridges.

Nomini Creek, Va.

Improving Nomini Creek, Virginia: Continuing improvement, five thousand dollars.

Pamunkey River, Va.

Improving Pamunkey River, Virginia: Continuing improvement, two thousand dollars.

Rappahannock River, Va.

Improving Rappahannock River, Virginia: Continuing improvement, ten thousand dollars.

Urbanna Creek, Va.

Improving Urbanna Creek, Virginia: Continuing improvement, three thousand dollars.

York River, Va.

Improving York River, Virginia: Continuing improvement, twenty thousand dollars.

Aquia Creek, Va.

Improving Aquia Creek, Virginia: Continuing improvement, three thousand dollars.

Occoquan Creek, Va.

Improving Occoquan Creek, Virginia: Continuing improvement, five thousand dollars.

James River, Jamestown Island, Va.

Protecting Jamestown Island from the encroachments of James River, ten thousand dollars, or so much thereof as may be necessary.

Lower Machodoc Creek, Va.

Improving Lower Machodoc Creek, Virginia: Continuing improvement, three thousand dollars.

Elk River, W. Va.

Improving Elk River, West Virginia: Continuing improvement, two thousand dollars.

Guyandotte River, W. Va.

Improving Guyandotte River, West Virginia: For maintenance, two thousand dollars.

Gauley River, W. Va.

Improving Gauley River, West Virginia: Continuing improvement, three thousand dollars.

Roanoke River, N. C.

Improving Roanoke River, North Carolina: Continuing improvement, thirty thousand dollars.

Waterway, Beaufort to New River, N. C.

Improving inland waterway between Beaufort Harbor and New River, North Carolina: Continuing improvement, two thousand five hundred dollars.

Trent River, N. C.

Improving Trent River, North Carolina: Continuing improvement, four thousand dollars.

North East River, N. C.

Improving North East [illegible] Fear, River, North Carolina: [illegible]tinuing impro[illegible] thousand dollars.

Pasquotank River, N. C.

Im[illegible] Pasquota[illegible] North Carolina: Com[illegible] ple[illegible]vement, [illegible] dollars.

Cape Fear River, N. C., above Wilmington.

[illegible] Cape Fe[illegible] Carolina, above Wil[illegible] [illegible]tinuing [illegible] thousand dol[illegible]

Below Wilmington.

[illegible] Cape [illegible] below Wil[illegible] mo[illegible] improvement, two hun[illegible] dol[illegible]

Pamlico and Tar rivers, N. C. Improving Pamlico and Tar Rivers, North Carolina, up to Rocky Mount: Continuing improvement, ten thousand dollars.

Contentnia Creek, N. C. Improving Contentnia Creek, North Carolina: Continuing improvement, ten thousand dollars.

Black River, N. C. Improving Black River, North Carolina: For maintenance, two thousand dollars.

Lumber River, N. C. and S. C. Improving Lumber River, North and South Carolina: Continuing improvement, four thousand dollars.

Neuse River, N. C. Improving Neuse River, North Carolina: Continuing improvement, seven thousand dollars.

Waterway, Norfolk, Va., to Albemarle Sound, N. C. Improving inland water route from Norfolk Harbor, Virginia, to Albemarle Sound, North Carolina, through Currituck Sound: Continuing improvement, ten thousand dollars.

Survey for ship canal, Va. and N. C. For the survey of the waterways through the sounds of North Carolina and for the survey of the Dismal Swamp Canal, Virginia and North Carolina, with a view of obtaining a depth of nine feet and the necessary width of a ship canal, and for the survey of the rivers and water connections connecting said canal with the sounds of North Carolina, five thousand dollars, or so much thereof as is necessary.

Lockwoods Folly River, N. C. Improving Lockwoods Folly River, North Carolina: Continuing improvement, ten thousand dollars.

Great Pedee River, S. C. Improving Great Pedee River, South Carolina: Continuing improvement, six thousand dollars.

Santee River, S. C. Improving Santee River, South Carolina: Continuing improvement, forty thousand dollars, to be used in snagging and in making new cut between Estherville and Minim Creek, and in maintaining the Musquito Creek Channel.

Waccamaw River, N. C. and S. C. Improving Waccamaw River, North and South Carolina, up to Lake Waccamaw: Continuing improvement, six thousand dollars.

Wappoo Cut, S. C. Improving Wappoo Cut, South Carolina: Continuing improvement, seven thousand dollars.

Wateree River, S. C. Improving Wateree River, South Carolina: For maintenance, two thousand five hundred dollars.

Congaree River, S. C. Improving Congaree River, South Carolina: Continuing improvement, four thousand dollars.

Mingo Creek, S. C. Improving Mingo Creek, South Carolina: For completion, four thousand dollars.

Little Pedee River, S. C. Improving Little Pedee River, South Carolina: Continuing improvement, four thousand dollars.

Beaufort River, S. C. Improving Beaufort River, South Carolina: Continuing improvement, five thousand dollars.

Altamaha River, Ga. Improving Altamaha River, Georgia: Continuing improvement, ten thousand dollars.

Chattahoochee River, Ga. and Ala. Improving Chattahoochee River, Georgia and Alabama: Continuing improvement, thirty thousand dollars, of which five thousand dollars are to be used on that portion of the river between West Point and Franklin, and ten thousand dollars in rebuilding snag boat.

Flint River, Ga. Improving Flint River, Georgia: Continuing improvement, eight thousand dollars.

Improving Ocmulgee River, Georgia: Continuing improvement, ten thousand dollars, of which five thousand dollars are to be expended between Macon and Hawkinsville and the like sum below Hawkinsville. Ocmulgee River, Ga.

Improving Oconee River, Georgia: Continuing improvement, ten thousand dollars, of which three thousand dollars are to be expended between Milledgeville and the Central Railroad Bridge. Oconee River, Ga.

Improving Savannah River, between Savannah and Augusta: Continuing improvement, fifteen thousand dollars. Savannah River, Ga., lower.

Improving Savannah River, above Augusta, Georgia: Continuing improvement, six thousand dollars. Above Augusta.

Improving Jekyl Creek, Georgia: Continuing improvement, four thousand dollars. Jekyl Creek, Ga.

Improving Coosa River, between Rome, Georgia, and the East Tennessee, Virginia and Georgia Railroad bridge, in Alabama: Continuing improvement, one hundred and ten thousand dollars. Coosa River, Ga. and Ala.

Improving Coosa River between Wetumka, Alabama, and the East Tennessee, Virginia and Georgia Railroad bridge: Continuing improvement, one hundred and ten thousand dollars. Coosa River, Ala.

Inside water route between Savannah, Georgia, and Fernandina, Florida: Continuing improvement, twenty thousand dollars. Waterway, Savannah to Fernandina.

Continuing improvement, Apalachicola River, Florida, including the cut-off, Lees Slough and Lower Chipola River: Five thousand dollars. Apalachicola River, Fla.

Improving Caloosahatchee River and Punta Rassa, Florida: For maintenance, two thousand dollars. Caloosahatchee River and Punta Rassa, Fla.

Improving Choctawhatchee River, Florida and Alabama: Continuing improvement, six thousand dollars: *Provided*, That no part of said sum shall be expended above Hollis bridge until a draw, approved by the Secretary of War, is put in said bridge. Choctawhatchee River, Fla. and Ala. *Proviso.* Drawbridge.

Improving Indian River, Florida, dredging channel from the channel of the Indian River through the Negro Cut to the bar at the Indian River inlet, five thousand dollars, and, in addition thereto, the Secretary of War is hereby authorized to expend in making said improvement the fifteen thousand dollars appropriated for the improvement of Indian River by act approved July thirteenth, eighteen hundred and ninety-two. Indian River, Fla. Vol. 27, p. 101.

Improving Escambia and Conecuh rivers, Florida: Continuing improvements, six thousand dollars. Escambia and Conecuh rivers, Fla.

Improving Manatee River, Florida: Continuing improvement, three thousand dollars. Manatee River, Fla.

Improving Suwanee River, Florida: Continuing improvement, three thousand dollars. Suwanee River, Fla.

Improving Volusia Bar, Florida: For maintenance, one thousand dollars. Volusia Bar, Fla.

Improving Ocklawaha River, Florida: For maintenance, three thousand dollars. Ocklawaha River, Fla.

Improving Sarasota Bay, Florida: Continuing improvement, two thousand five hundred dollars. Sarasota Bay, Fla.

Withlacoochee River, Fla.

Improving Withlacoochee River, Florida: For maintenance, including a survey of the mouth of said river, eight hundred dollars.

Alabama River, Ala.

Improving Alabama River, Alabama: Continuing improvement, fifty thousand dollars.

Black Warrior River, Ala.

Improving Black Warrior River, Alabama, from Tuscaloosa to Daniels Creek: Continuing improvement, thirty-seven thousand five hundred dollars; and the Secretary of War shall cause a survey of said river to be made for its further improvement to the Mulberry and Locust Fork, in harmony as to width and depth of channel with the work now being done between Tuscaloosa and Daniels Creek, and the expense of said survey shall be paid out of this appropriation.

Survey.

Warrior and Tombigbee rivers, Ala.

Distribution.

Improving Warrior and Tombigbee rivers, Alabama, from mouth of Tombigbee River to Tuscaloosa: Continuing improvement, one hundred and fifteen thousand dollars, of which seventy-five thousand dollars are to be expended on the Tombigbee River and forty thousand dollars on the Warrior River; and so much of said sums as may be necessary is authorized to be expended in acquiring, by purchase or condemnation, under the laws of Alabama, the lands needed in making such improvements.

Tombigbee River, Ala. and Miss.

Improving Tombigbee River from Fulton to Columbus: Continuing improvement, four thousand dollars.

Improving Tombigbee River from Demopolis, Alabama, to Columbus, Mississippi: Continuing improvement, fifty thousand dollars.

Improving Tombigbee River, from Walkers Bridge to Fulton: Continuing improvement, one thousand dollars.

Big Sunflower River, Miss.

Improving Big Sunflower River, Mississippi: Continuing improvement, five thousand dollars.

Noxubee River, Miss.

Improving Noxubee River, Mississippi: For maintenance, three thousand dollars.

Pascagoula River, Miss.

Improving Pascagoula River, Mississippi: Continuing improvement, thirteen thousand dollars, and so much of said sum as may be necessary may be used for removal of the bar in Horn Island Pass.

Pearl River, Miss.

Improving Pearl River, Mississippi, between Edinburg and Carthage: For maintenance, five hundred dollars.

Improving Pearl River, between Carthage and Jackson, Mississippi: For completion, two thousand four hundred dollars.

Improving Pearl River, Mississippi, below Jackson: Continuing improvement, five thousand dollars, which, in the discretion of the Secretary of War, may be expended north of Columbia.

Tallahatchee River, Miss.

Improving Tallahatchee River, Mississippi: Continuing improvement, four thousand dollars.

Tehula Lake, Miss.

Improving Tehula Lake, Mississippi: Continuing improvement, three thousand dollars.

Yazoo River, Miss.

Improving Yazoo River, Mississippi: Continuing improvement, twenty thousand dollars, of which so much as may be necessary shall be expended in removing the bar at Yazoo City and the bars at the upper and lower ends of Tehula Lake, beginning with the bar at Yazoo City.

Improving Chickasahay River, Mississippi, from the mouth up to railroad bridge, near Shubuta: Continuing improvement, five thousand dollars. Chickasahay River, Miss.

Improving Leaf River, Mississippi, from its mouth to Bowie Creek: Continuing improvement, two thousand five hundred dollars. Leaf River, Miss.

Improving mouth of the Yazoo River, Mississippi: Continuing improvement, two hundred and twenty-five thousand dollars, to be expended in accordance with plan of Captain J. H. Willard, Corps of Engineers, as set out in House Executive Document, numbered one hundred and twenty-five, of the first session, Fifty-second Congress. Yazoo River, Miss., at mouth.

Improving Amite River and Bayou Manchac, Louisiana: For maintenance, two thousand five hundred dollars. Amite River, and Bayou Manchac, La.

Improving Boeuf River, Louisiana: Continuing improvement, eight thousand dollars. Boeuf River, La.

Improving Bayou Bartholomew, Louisiana and Arkansas: Continuing improvement, five thousand dollars. Bayou Bartholomew, La. and Ark.

Improving bayous D'Arbonne and Corney, Louisiana: Continuing improvement, three thousand dollars, of which one thousand dollars shall be expended in removing obstructions from the Little D'Arbonne. Bayous D'Arbonne and Corney, La.

Improving Tensas River and Bayou Macon, Louisiana and Arkansas: Continuing improvement, five thousand dollars. Tensas River, and Bayou Macon, La. and Ark.

Improving Red River, Louisiana and Arkansas, from Fulton, Arkansas, to the Atchafalaya River: Continuing improvement according to the plan of Captain J. H. Willard, Corps of Engineers, United States Army, and for completion of survey, one hundred and fifty thousand dollars, of which fifteen thousand dollars, or so much thereof as may be necessary, shall be used in the further prosecution of the work at Alexandria, and five thousand dollars for improving the Sulphur River, a tributary of the Red River. Red River, La. and Ark.

Improving Tickfaw River, Louisiana: For maintenance, one thousand dollars. Tickfaw River, La.

Improving Bayou Plaquemine, Louisiana: Continuing improvement, one hundred and ten thousand dollars, of which sum not exceeding ten thousand dollars may be used, in the discretion of the Secretary of War, in removing obstructions from Grand River and Pigeon bayous, forming part of the Bayou Plaquemine route. Bayou Plaquemine, La.

Improving Bayou Lafourche, Louisiana: Continuing improvement and removing obstructions, forty thousand dollars, and a dredge boat for use in said bayou is hereby authorized to be constructed, the expense of same to be paid out of this appropriation. Bayou Lafourche, La.

Improving Chefuncte River and Bouge Falia, Louisiana: For maintenance, one thousand dollars. Chefuncte River and Bogue Falia, La.

Improving Bouge Chitto, Louisiana: Continuing improvement, five thousand dollars. Bogue Chitto, La.

Improving Mermentau River and tributaries, Louisiana: Continuing improvement, five thousand dollars. Mermentau River, etc., La.

Improving channel, bay, and passes of Bayou Vermilion, Louisiana: Continuing improvement, five thousand dollars. Bayou Vermilion, La.

Bayou Courtableau, La.

Improving Bayou Courtableau, Louisiana: Continuing improvement, five thousand dollars.

Bayou Teche, La.

Improving Bayou Teche, Louisiana: Continuing improvement, six thousand dollars.

Buffalo Bayou, Tex.

Improving Buffalo Bayou, Texas: Continuing improvement, fifteen thousand dollars.

Trinity River, Tex.

Improving Trinity River, Texas: Continuing improvement, including survey from Magnolia to the city of Dallas, five thousand dollars.

Cypress Bayou, Tex.

Improving Cypress Bayou, Texas: For dredging and removing obstructions and straightening channel between Jefferson, Texas, and Shreveport, Louisiana, ten thousand dollars.

Sabine River, Tex.

Improving Sabine River, Texas: For completion, five thousand dollars.

Arkansas River, Ark. and Ind. Ter.

Improving Arkansas River, Arkansas and Indian Territory: Continuing improvement, two hundred and fifty thousand dollars, two-fifths of which amount shall be expended from the mouth of the river to Little Rock, and a portion of which, may in the discretion of the Secretary of War, be used to prevent the further caving of the bank near Red Fork, two-fifths from Little Rock to Fort Smith, and one-fifth above Fort Smith: *Provided*, That, in the discretion of the Secretary of War, ten thousand dollars of the amount hereby appropriated for said river may be used in removing obstructions and operating snag boats.

Proviso.

Snag boats, etc.

Saint Francis River, Ark.

Improving Saint Francis River, Arkansas: Continuing improvement, eighty-three thousand dollars, seventy-five thousand dollars of which to be expended by the Mississippi River Commission for the prevention of a formation of a cut through to the Saint Francis River by the action of the overflow water from the Mississippi River, as recommended in the report of Colonel Charles R. Suter, dated May twenty-ninth, eighteen hundred and ninety-four.

Prevention of cut. Mississippi River Commission.

Arkansas River. Snag boats, etc.

Improving Arkansas River: Removing obstructions and operating snag boats, twenty thousand dollars.

Black River, Ark. and Mo.

Improving Black River, Arkansas and Missouri: Continuing improvement, nine thousand five hundred dollars.

White River, Ark.

Improving White River, Arkansas: Continuing improvement, fifty-two thousand dollars, of which two thousand dollars may, in the discretion of the Secretary of War, be expended in removing obstructions in Cache River, and eight thousand dollars in the rectification of the channel of the White River at Batesville.

Ouachita and Black rivers, Ark. and La.

Improving Ouachita and Black rivers, Arkansas and Louisiana: Continuing improvement, fifty thousand dollars: and the Secretary of War is directed to submit, with his next report on the Ouachita River, plans and estimates for the improvement of said Ouachita River by locks and dams, to give slackwater navigation as far above its mouth as in his judgment such improvement is practicable, the cost of the same to be paid out of this appropriation.

Red River, Ark.

Improving Red River above Fulton, Arkansas: Continuing improvement three thousand five hundred dollars.

Current River, Ark. and Mo.

Improving Current River, Arkansas and Missouri: Continuing improvement in accordance with the project sub-

mitted by H. S. Tabor, captain of engineers, on December eleventh, eighteen hundred and ninety, eight thousand dollars, of which four thousand three hundred and fifty dollars may be used in building a snag boat and rock barge.

Clinch River, Tenn. Improving Clinch River, Tennessee: Continuing improvement, two thousand five hundred dollars.

Cumberland River. Improving Cumberland River, Kentucky and Tennessee: Continuing improvement above Nashville, two hundred thousand dollars, of which five thousand dollars may be used, in the discretion of the Secretary of War, above the town of Burnside.

Improving Cumberland River below Nashville, Tennessee: Continuing improvement, thirty thousand dollars.

French Broad and Little Pigeon rivers, Tenn. Improving French Broad and Little Pigeon rivers, Tennessee: Continuing improvement, seven thousand dollars.

Tennessee River. Below Chattanooga, Tenn. Distribution. Improving Tennessee River below Chattanooga, Tennessee: Continuing improvement, four hundred thousand dollars, of which twenty-five thousand dollars may, in the discretion of the Secretary of War, be used in continuing the work at Livingston Point, Kentucky, and ten thousand dollars in improving the river between Hobbs Island and Guntersville, and one hundred thousand dollars below Riverton, of which last sum ninety-thousand dollars, or so much thereof as may be necessary, shall be used in the removal of snags and other obstructions to navigation between Riverton and the mouth of said Tennessee River, and the remainder of said sum of one hundred thousand dollars, or so much thereof as may be necessary, shall be used in making a survey of said Tennessee River below Riverton and submitting plans for its improvement.

Above Chattanooga, Tenn. Improving Tennessee River above Chattanooga, Tennessee, fifty thousand dollars, to be expended in accordance with the project submitted by Lieutenant-Colonel Henry M. Robert, on February twenty-third, eighteen hundred and ninety-three, and printed in House Executive Document numbered two hundred and fifty-two, second session of Fifty-second Congress.

Obion River, Tenn. Improving Obion River, Tennessee, from its mouth to the town of Obion on the Newport News and Mississippi Valley Railroad, in Obion County: Continuing improvement, seven thousand five hundred dollars.

Kentucky River, Ky. Improving Kentucky River, Kentucky: Continuing improvement, one hundred and thirty-five thousand dollars, of which ten thousand dollars shall be used in improving Rough River, Kentucky.

Falls of the Ohio River, Ky. Improving the Falls of the Ohio River, Kentucky: Continuing improvement, sixty thousand dollars.

Indiana Chute, Ky. Improving Indiana Chute, Falls of the Ohio River, Kentucky: Continuing improvement, twenty thousand dollars.

Rough River, Ky. Improving Rough River, Kentucky: Continuing improvement, twelve thousand five hundred dollars.

Big Sandy River, Ky. Levisa Fork. Improving Levisa Fork, Big Sandy River, Kentucky: For maintenance, two thousand five hundred dollars.

Tug Fork. Improving Tug Fork, Big Sandy River, Kentucky: For maintenance, two thousand five hundred dollars.

Fox River, Wis.

Improving Fox River, Wisconsin: Continuing improvement, thirty-seven thousand five hundred dollars, of which twenty-five hundred dollars, or so much thereof as may be necessary, may be used for work in the harbor of Fond du Lac, Wisconsin, and approaches thereto; of which said sum, two thousand five hundred dollars, or so much thereof as shall be necessary, shall be used in the removal of the bar that exists at the intersection of Fox River with Big Lake Buttes-desmorts, and five thousand dollars, or so much thereof as may be necessary, may be used in erecting, operating, and maintaining on the Menasha dam flash boards to be so adjusted as to raise said dam one foot in height: *Provided, however*, That said dam shall not be raised if, in the judgment of the engineers or the Secretary of War, there is any possibility of any damage whatsoever being inflicted upon any private property by flowage of water or otherwise.

Proviso. Raising dam.

Saint Croix River, Wis. and Minn.

Improving Saint Croix River, Wisconsin and Minnesota: Continuing improvement, four thousand dollars.

Menominee River, Mich. and Wis.

Improving Menominee River, Michigan and Wisconsin: Continuing improvement, six thousand dollars.

Sturgeon Bay and Lake Michigan Ship Canal.

Improving Sturgeon Bay and Lake Michigan Ship Canal: Continuing improvement, twenty thousand dollars.

Red River of the North, Minn.

Improving Red River of the North, Minnesota: Continuing improvement, fifteen thousand dollars.

Wabash River, Ind. and Ill.

Improving Wabash River, Indiana and Illinois, above Vincennes: Continuing improvement, five thousand dollars.

Improving Wabash River, Indiana and Illinois, below Vincennes: Continuing improvement, fifteen thousand dollars.

White River, Ind.

Improving White River, Indiana: Continuing improvement, including a resurvey of said river, five thousand dollars.

Calumet River, Ind. and Ill.

Improving Calumet River, Indiana and Illinois: Continuing improvement, forty-five thousand dollars, of which thirty-five thousand dollars is to be used below the forks of the river and ten thousand dollars above the forks to one-half mile east of Hammond.

Illinois River, Ill.

Improving Illinois River, Illinois: Continuing improvement, thirty-five thousand dollars.

Illinois and Mississippi Canal.

For construction of the Illinois and Mississippi Canal: Continuing construction, one hundred and ninety thousand dollars.

So much of the Iowa River within the State of Iowa as lies between the town of Toolsboro and the town of Wapello, in the county of Louisa, shall not be deemed a navigable river or public highway, but dams and bridges may be constructed across it.

For examination and survey for the location of a canal connecting Lake Superior and the Mississippi River, ten [illegible]

Improving Ohio River, Ohio: Continuing improvement, two hundred and fifty thousand dollars, of which twelve thousand dollars shall be used in continuing the work at Shawneetown; twenty-five thousand dollars, or so much thereof as may be necessary, in preventing the cut-off threatened at the peninsula near Evansville, Indiana; eighteen thousand seven hundred and fifty dollars, or so much thereof as may be necessary, in constructing an additional ice pier at Middleport, Ohio, pursuant to the plans of the Chief of Engineers, and in enlarging and improving the ice pier at Pomeroy, Ohio, and in constructing an ice pier at or near Syracuse, Ohio, or at or near Hartford, West Virginia, upon the plans heretofore adopted for such piers in the Ohio River. The precise points for the construction of said piers at said localities shall be fixed by the Secretary of War so as to best accommodate the commerce of those sections of said river.

Ohio River.

Shawneetown.

Evansville, Ind.

Middleport, Ohio.

Ice piers.

Improving Ohio River by the construction of a movable dam at or below the mouth of Beaver River, Pennsylvania: Continuing improvement, seventy-five thousand dollars.

Ohio River. Movable dam.

Improving Saginaw River, Michigan: Continuing improvement, forty thousand dollars, of which sixteen thousand dollars, or such less sum as may be necessary, shall be expended on the river above Bay City.

Saginaw River, Mich.

Improving Saint Clair Flats Ship Canal, Michigan: All work pertaining to this canal is hereby declared to be embraced within the project adopted by the Act approved July thirteenth, eighteen hundred and ninety-two, and the Secretary of War is directed to perform the same in accordance therewith.

Saint Clair Flats Canal, Mich.

Character of work.

Vol. 27, p. 108.

Improving Black River, at Port Huron, Michigan: Continuing improvement up to Washington avenue, four thousand dollars.

Black River, Mich.

Improving mouth of Black River, Michigan: Continuing improvement, four thousand dollars.

Improving Clinton River, Michigan: Continuing improvement, five thousand dollars.

Clinton River, Mich.

Improving Rouge River, Michigan: Continuing improvement, five thousand dollars.

Rouge River, Mich.

Improving Detroit River, Michigan, by removal of shoals from the city of Detroit to Lake Erie: Continuing improvement, thirty thousand dollars.

Detroit River, Mich.

Improving Alpena Harbor, Michigan: Continuing improvement, four thousand dollars.

Alpena Harbor, Mich.

Improving the water communication across Keweenaw Point, Lake Superior, from Keweenaw Bay to Lake Superior, in the State of Michigan, in accordance with the existing project, one hundred and thirty thousand dollars.

Waterway, Keweenaw Bay to Lake Superior.

Improving Saint Joseph River, Michigan: Continuing improvement, five hundred dollars.

Saint Joseph River, Mich.

Improving Chippewa River, including Yellow Banks, Wisconsin: Continuing improvement, including a survey of the river for two miles south of the Dells Dam, ten thousand dollars.

Chippewa River, Wis.

Fox River, Wis.

Improving Fox River, Wisconsin: Continuing improvement, thirty-seven thousand five hundred dollars, of which twenty-five hundred dollars, or so much thereof as may be necessary, may be used for work in the harbor of Fond du Lac, Wisconsin, and approaches thereto; of which said sum, two thousand five hundred dollars, or so much thereof as shall be necessary, shall be used in the removal of the bar that exists at the intersection of Fox River with Big Lake Buttesdesmorts, and five thousand dollars, or so much thereof as may be necessary, may be used in erecting, operating, and maintaining on the Menasha dam slash boards to be so adjusted as to raise said dam one foot in height: *Provided, however*, That said dam shall not be raised if, in the judgment of the engineers or the Secretary of War, there is any possibility of any damage whatsoever being inflicted upon any private property by flowage of water or otherwise.

Proviso. Raising dam.

Saint Croix River, Wis. and Minn.

Improving Saint Croix River, Wisconsin and Minnesota: Continuing improvement, four thousand dollars.

Menominee River, Mich. and Wis.

Improving Menominee River, Michigan and Wisconsin: Continuing improvement, six thousand dollars.

Sturgeon Bay and Lake Michigan Canal.

Improving Sturgeon Bay and Lake Michigan Ship Canal: Continuing improvement, twenty thousand dollars.

Red River of the North, Minn.

Improving Red River of the North, Minnesota: Continuing improvement, fifteen thousand dollars.

Wabash River, Ind. and Ill.

Improving Wabash River, Indiana and Illinois, above Vincennes: Continuing improvement, five thousand dollars.

Improving Wabash River, Indiana and Illinois, below Vincennes: Continuing improvement, fifteen thousand dollars.

White River, Ind.

Improving White River, Indiana: Continuing improvement, including a resurvey of said river, five thousand dollars.

Calumet River, Ind. and Ill.

Improving Calumet River, Indiana and Illinois: Continuing improvement, forty-five thousand dollars, of which thirty-five thousand dollars is to be used below the forks of the river and ten thousand dollars above the forks to one-half mile east of Hammond.

Illinois River, Ill.

Improving Illinois River, Illinois: Continuing improvement, thirty-five thousand dollars.

Illinois and Michigan Canal.

For construction of the Illinois and Mississippi Canal: Continuing construction, one hundred and ninety thousand dollars.

Iowa River. Part declared not navigable.

So much of the Iowa River within the State of Iowa as lies between the town of Toolsboro and the town of Wapello, in the county of Louisa, shall not be deemed a navigable river or public highway, but dams and bridges may be constructed across it.

Lake Superior and Mississippi River. Survey for canal to connect.

For examination and survey for the location of a canal connecting Lake Superior and the Mississippi River, ten thousand dollars; and the engineers making said examination and survey shall report the most feasible route for such canal, either by way of the Saint Croix, Rum, or Upper Mississippi rivers: *Provided*, That nothing herein shall be construed to commit the Government to proceed with the construction of said improvement.

Proviso. Construction not binding.

Mississippi River.

Reservoirs at head-waters.

For care and maintenance of reservoirs at the head-waters of the Mississippi River, fifty-one thousand dollars, and so much thereof as shall be required shall be expended in completing connections with the reservoir dams; in completing Sandy Lake dam; and any balance may be used for the construction of a reservoir and dam at Gull Lake, Minnesota: *Provided*, That the United States shall not be subject to any cost or expense for lands, mills, or other property necessarily taken or injured for the last-named reservoir and dam. The provisions of section four of an act entitled "An Act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," approved July fifth, eighteen hundred and eighty-four, are hereby made applicable to said reservoirs so far as concerns their care, preservation, and maintenance. For dredging the channel at Quincy Bay, at Quincy, Illinois, the Secretary of War is hereby authorized to set apart, out of any appropriations heretofore made, or which may be made, by this Congress for continuing the improvement of the Mississippi River, from the mouth of the Missouri River to Minneapolis, the sum of fifteen thousand dollars, if, in his discretion, said sum shall be necessary for that purpose. And out of said appropriation he shall cause a survey to be made on the west side of the Mississippi River, commencing at the mouth of Flint Creek, in Des Moines County, State of Iowa, and running along the west bank of the river to the mouth of the Iowa River, and along the east bank of the Mississippi River from the city of Warsaw to the city of Quincy, with a view to improving the navigation by preventing the water from overflowing the natural and artificial banks along those parts of the river and deepening the channel.

Proviso.

No cost for lands, etc.

Maintenance.

Vol. 23, p. 147.

Quincy, Ill.

Survey to prevent overflows.

From Saint Paul to Minneapolis, Minn.

Improving the Mississippi River between the Chicago, Saint Paul, Minneapolis and Omaha Railroad bridge at Saint Paul to the Washington Avenue bridge at Minneapolis, fifty-one thousand dollars, which together with the unexpended balance standing to the credit of this improvement shall be expended under the project or plan to extend navigation from Saint Paul to the flour mills at Minneapolis, estimated for by Major A. McKenzie as appears by his report made to General Thomas L. Casey, Chief of Engineers, United States Army, under date of March first, eighteen hundred and ninety-four, by the construction of lock and dam numbered two in the same project.

Work under Mississippi River Commission.

For work in accordance with the plans and specifications of the Mississippi River Commission:

Greenville, Miss.

At the harbor of Greenville, Mississippi: Continuing improvement, eighty thousand dollars.

New Madrid, Mo.

At the harbor of New Madrid, Missouri: Continuing improvement, twenty thousand dollars.

New Orleans, La.

At the harbor of New Orleans, Louisiana: Continuing improvement, one hundred and ten thousand dollars.

Natchez and Vidalia, Miss. and La.

At the harbor of Natchez and Vidalia, Mississippi and Louisiana: Continuing improvement, eighty thousand dollars.

Memphis, Tenn.

At the harbor of Memphis, Tennessee: Continuing improvement, fifty thousand dollars, of which ten thousand dollars may be used in dredging at the mouth of Wolf River, in the discretion of the Secretary of War.

Hickman, Ky. Unexpended balance.

The Mississippi River Commission shall cause to be expended on the harbor at Hickman, Kentucky, the unexpended balance, of any appropriation heretofore made for improving the harbor at that point.

Atchafalaya and Red rivers, La.

At the head of the Atchafalaya and the mouth of Red River, Louisiana, for the rectification thereof: Continuing improvement, seventy thousand dollars, of which two thousand five hundred dollars may be used in improving Bayou Des Glaises, in the parish of Avoyelles, and the said Commission is directed to report to Congress in their next regular report their views on the advisability of effecting a separation between the Mississippi and Red rivers at the present junction thereof and maintaining navigation between the same through Bayou Plaquemine or by means of a canal.

Saint Francis River, Mo.

Improving Saint Francois River, in Missouri, five thousand dollars.

Gasconade River, Mo.
Osage River, Mo.

Improving Gasconade River, Missouri: Continuing improvement, five thousand dollars; and improving Osage River, Missouri: Continuing improvement, forty-six thousand dollars, to be expended by the Missouri River Commission.

Missouri River Commission.
Distribution.

Missouri River, from its mouth to the lower limits of Sioux City, Iowa: The Missouri River Commission is authorized and directed to expend from the appropriations for the improvement of said river seventy-five thousand dollars in the rectification of the river at Omaha, Nebraska; thirty-five thousand dollars at Atchison, Kansas; and fifty thousand dollars at Saint Joseph and other localities on the river in the State of Missouri where the Commission may deem such improvement necessary.

Upper Missouri River, between Stubbs' Ferry, Mont. and Sioux City Iowa.
Distribution.

Improving Upper Missouri River between Stubbs' Ferry, in Montana, and the lower limits of Sioux City, Iowa: One hundred and ten thousand dollars, of which ten thousand dollars may be expended in the protection and completion of the works at Sioux City; forty thousand dollars are to be expended in the rectification of the river at Pierre and Fort Pierre; forty thousand dollars, in the discretion of the Secretary of War, may be used for the protection of Bismarck Harbor and the rectification of the river by works to prevent the river from eroding the banks and cutting a new channel at or near that point; twenty thousand dollars shall be expended between the Great Falls of said river, in Montana, and Stubbs' Ferry, in Montana.

Sacramento and Feather rivers Cal.

Improving Sacramento and Feather Rivers, California: Continuing improvements, including treatment of the Yuba River, near and above Marysville, and of the Bear River, one hundred and fifteen thousand dollars; of which ten thousand dollars, or so much thereof as may be necessary, shall be expended in snagging and other work between Tehama and Redding, on the Sacramento River; and, in the discretion of the Secretary of War, ten thousand dol-

lars, or so much thereof as may be necessary, shall be expended in making a cut-off to avoid Shanghai bend on Feather River: *Provided*, That no money shall be expended in making said cut-off until the right of way therefor shall have been conveyed to the United States free of expense.

Proviso.

Right of way.

San Joaquin River, Cal.

Improving San Joaquin River, California, including making cut-off at Twenty-one Mile Slough; and if, in the discretion of the Secretary of War, it is deemed beneficial to navigation by preventing deposit of sediment in Stockton Channel, or otherwise, the making of a double cut-off beginning at Mormon Slough immediately above its junction with Stockton Channel, thence across the same, entering the San Joaquin River immediately below junction therewith of Stockton Channel: Continuing improvement, fifty thousand dollars, of which ten thousand dollars, or so much thereof as may be necessary, shall be expended in snagging and other work in aid of navigation on the San Joaquin River, above the city of Stockton and in the Tuolumne River and other tributaries of the former: *Provided*, That no money shall be expended in making said double cut-off until the right of way therefor shall have been conveyed to the United States free of charge.

Cut-off, etc.

Proviso.

Right of way.

Petaluma Creek, Cal.

Improving Petaluma Creek, California: Continuing improvement, fifteen thousand dollars.

Mokelumne River, Cal.

Improving Mokelumne River, California: Continuing improvement, two thousand five hundred dollars, including snagging as far as county bridge at Thornton's, on said river: *Provided*, That no part of said sum shall be used until the drainage canal cut by private parties near New Hope landing shall have been closed.

Proviso.

Drainage canal.

Napa River, Cal.

Improving Napa River, California: Continuing improvement, four thousand dollars.

Columbia River, upper.

Improving Upper Columbia River, including Snake River as far up as Asotin, Oregon and Washington: Continuing improvement, five thousand dollars.

Rapids. Rock Island to Foster Creek.

Snag boat, etc.

Improving Columbia River from Rock Island Rapids to Foster Creek Rapids: The Secretary of War may, in his discretion, expend the unexpended balance, eight thousand two hundred and ten dollars and ninety-two cents, of the appropriation heretofore made for the improvement of the Columbia River between the head of Rock Island Rapids and the foot of Priest Rapids, Washington, for the building of a snag boat for use on the Columbia River between Rock Island Rapids and Foster Creek Rapids, and for such other work as may be necessary for the improvement of navigation of said river within the above-named limits.

Mouth.

Improving mouth of Columbia River, Oregon, and Washington: Completing improvement, three hundred and thirty-eight thousand one hundred and eighty dollars.

Boat railway at The Dalles Rapids.

Improving Columbia River, Oregon and Washington, at Three-Mile Rapids, and the construction and equipment of a boat railway from the foot of The Dalles Rapids to the head of Celilo Falls, said boat railway to be provided at each terminus with hydraulic lifts, and other necessary appliances, for the purpose of raising and lowering the boats on suitable cars to and from its tracks, the whole to

be located, constructed, and equipped for the passage of eight boats of six hundred tons each in each direction in twelve hours, on the south side of the Columbia River, substantially in accordance with the location and plans submitted by the board of engineers, appointed by the President in pursuance of the provision of the Act of Congress approved July thirteenth, eighteen hundred and ninety-two, and entitled "An Act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," with their report, which is contained in Senate Executive Document Numbered Seven, Fifty-third Congress, first session, one hundred thousand dollars: *Provided*, That the Secretary of War is hereby authorized and directed to proceed to acquire without unnecessary delay by purchase or condemnation, in the manner and according to the conditions now prescribed by law, the necessary right of way for said boat railway and the right to the use of lands required for terminal and other facilities for said boat railway, and to expend so much of the amount hereby appropriated as may be necessary for that purpose.

Vol. 27, p. 109.

Proviso. Right of way, etc., to be secured.

Lower Willamette and Columbia rivers, Oreg. and Wash.

Improving Lower Willamette River in front of and below Portland, Oregon, and Columbia River below the Willamette River in Oregon and Washington: Continuing improvement, fifty thousand dollars.

Willamette River, Oreg.

Improving Willamette River above Portland, Oregon: Continuing improvement, twenty-three thousand dollars, of which eight thousand dollars, or so much thereof as may be necessary, shall be used at Corvallis, and two thousand dollars may, in the discretion of the Secretary of War, be used in the removal of obstructions in Yam Hill River up to McMinnville.

Coquille River, Oreg.

Improving Coquille River, Oregon: Continuing improvement, twenty thousand dollars.

Upper Coquille River, Oreg.

Improving Upper Coquille River, between Coquille City and Myrtle Point, Oregon: Continuing improvement, five thousand dollars.

Siuslaw River, Oreg.

Improving the mouth of Siuslaw River: Continuing improvement, twenty-five thousand dollars.

Gauging Columbia River.

For gauging waters of the Columbia River, measuring tidal and river volumes, one thousand dollars.

Upper Snake River, Idaho.

Improving Upper Snake River, Idaho, between Seven Devils mining district and Huntington bridge, twenty-five thousand dollars.

Cowlitz River, Wash.

Improving Cowlitz River, Washington: Continuing improvement, three thousand dollars.

Puget Sound, etc., Wash.

Improving Puget Sound and its tributary waters, Washington: Continuing improvement, fourteen thousand dollars, which, together with the unexpended balance, may, in the discretion of the Secretary of War, or so much thereof as shall be necessary, be used for repairs to snag boat.

Swinomish Slough, Wash.

Improving Swinomish Slough, Washington: Continuing improvement in accordance with existing plan, twenty-five thousand dollars.

Willapa River, Wash.

Improving Willapa River and Harbor, Washington: For

completion, thirteen thousand three hundred and fifty dollars: *Provided*, That in the discretion of the Secretary of War two thousand five hundred dollars of the amount hereby appropriated for said river and harbor may be used in removing obstructions in North River. *Proviso.* Removing obstructions.

For dredging Salmon Bay, and the improvement of the waterway connecting the waters of Puget Sound, at Salmon Bay, with lakes Union and Washington by enlarging the said waterway into a ship canal, with the necessary locks and appliances in connection therewith, twenty-five thousand dollars: *Provided*, That no part of said amount shall be expended on the improvement of the waterway connecting the waters of Puget Sound with lakes Union and Washington until the entire right of way and a release from all liability to adjacent property owners have been secured to the United States free of cost and to the satisfaction of the Secretary of War. Waterway, Puget Sound to lakes Union and Washington. *Proviso.* Right of way to be secured free.

For dredging Everett Harbor, including mouth of Snohomish River, and Snohomish River from mouth to Lowell, in the State of Washington, the sum of ten thousand dollars. Everett, Wash.

SEC. 2. It shall be unlawful for any person or persons to engage in fishing or dredging for shell fish in any of the channels leading to and from the harbor of New York, or to interfere in any way with the safe navigation of those channels by ocean steamships and ships of deep draft. New York Harbor. Fishing, etc., in ship channels forbidden.

Any person or persons violating the foregoing provisions of this section shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by fine or imprisonment, or both, such fine to be not more than two hundred and fifty dollars nor less than fifty dollars, and the imprisonment to be not more than six months nor less than thirty days, either or both united, as the judge before whom conviction is obtained shall decide. Penalty for violations.

It shall be the duty of the United States supervisor of the harbor to enforce this Act, and the deputy inspectors of the said supervisor shall have authority to arrest and take into custody, with or without process, any person or persons who may commit any of the acts or offenses prohibited by this Act: *Provided*, That no person shall be arrested without process for any offense not committed in the presence of the supervisor or his inspector or deputy inspectors, or either of them: *And provided further*, That whenever any such arrest is made the person or persons so arrested shall be brought forthwith before a commissioner, judge, or court of the United States for examination of the offenses alleged against him; and such commissioner, judge or court shall proceed in respect thereto as authorized by law in case of crimes against the United States. Arrests. *Provisos.* Process. Proceedings.

SEC. 3. That section three of the "Act to prevent obstructive and injurious deposits within the harbor and adjacent waters of New York City, by dumping or otherwise, and to punish and prevent such offenses," approved June twenty-ninth, eighteen hundred and eighty-eight, shall be, and hereby is, amended so as to read as follows: New York Harbor. Law prohibiting injurious deposits amended. Vol. 25, p. 209.

"SEC. 3. That in all cases of receiving on board of any scows or boats such forbidden matter or substance as herein Supervisor to designate place of deposit.

described, the owner or master, or person acting in such capacity on board of such scows or boats, before proceeding to take or tow the same to the place of deposit, shall apply for and obtain from the supervisor of the harbor appointed hereunder a permit defining the precise limits within which the discharge of such scows or boats may be made; and it shall not be lawful for the owner or master, or person acting in such capacity, of any tug or towboat to tow or move any scow or boat so loaded with such forbidden matter until such permit shall have been obtained; and every person violating the foregoing provisions of this section shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine of not more than one thousand nor less than five hundred dollars, and in addition thereto the master of any tug or towboat so offending shall have his license revoked, or suspended for a term to be fixed by the judge before whom tried and convicted.

Permits.

Penalty for violating.

Penalty for discharging at other places.

"And any deviation from such dumping or discharging place specified in such permit shall be a misdemeanor, and the owner and master, or person acting in the capacity of master, of any scows or boats dumping or discharging such forbidden matter in any place other than that specified in such permit shall be liable to punishment therefor as provided in section one of the said Act of June twenty-ninth, eighteen hundred and eighty-eight; and the owner and master, or person acting in the capacity of master, of any tug or towboat towing such scows or boats shall be liable to equal punishment with the owner and master, or person acting in the capacity of master, of the scows or boats; and, further, every scowman or other employee on board of both scows and towboats shall be deemed to have knowledge of the place of dumping specified in such permit, and the owners and masters, or persons acting in the capacity of masters, shall be liable to punishment, as aforesaid, for any unlawful dumping, within the meaning of this Act or of the said Act of June twenty-ninth, eighteen hundred and eighty-eight, which may be caused by the negligence or ignorance of such scowman or other employee; and, further, neither defect in machinery nor avoidable accidents to scows or towboats, nor unfavorable weather, nor improper handling or moving of scows or boats of any kind whatsoever, shall operate to release the owners and masters and employees of scows and towboats from the penalties hereinbefore mentioned."

Persons liable.

Boats to have name, etc. painted.

Every scow or boat engaged in the transportation of dredgings, earth, sand, mud, cellar dirt, garbage, or other offensive material of any description shall have its name or number and owner's name painted in letters and numbers at least fourteen inches long on both sides of the scow or boat: these names and numbers shall be kept distinctly legible at all times, and no scow or boat not so marked shall be used to transport or dump any such material.

Appointment of inspectors.
Vol 25, p. 210

The supervisor of the harbor of New York, designated as provided in section five of the said Act of June twenty-ninth, eighteen hundred and eighty-eight, is authorized

and directed to appoint inspectors and deputy inspectors, and, for the purpose of enforcing the provisions of this Act and of the Act aforesaid, and of detecting and bringing to punishment offenders against the same, the said supervisor of the harbor and the inspectors and deputy inspectors so appointed by him, shall have power and authority:

Duties. Arrests.

First. To arrest and take into custody, with or without process, any person or persons who may commit any of the acts or offenses prohibited by this section and by the act of June twenty-ninth, eighteen hundred and eighty-eight, aforesaid, or who may violate any of the provisions of the same: *Provided*, That no person shall be arrested without process for any offense not committed in the presence of the supervisor or his inspectors or deputy inspectors, or either of them: *And provided further*, That whenever any such arrest is made the person or persons so arrested shall be brought forthwith before a commissioner, judge, or court of the United States for examination of the offenses alleged against him; and such commissioner, judge, or court shall proceed in respect thereto as authorized by law in case of crimes against the United States.

Provisos. **Process.**

Custody of offender.

Seizure of boats.

Second. To go on board of any scow or towboat engaged in unlawful dumping of prohibited material, or in moving the same without a permit as required in this section of this Act, and to seize and hold said boats until they are discharged by action of the commissioner, judge, or court of the United States before whom the offending persons are brought.

Custody of witness.

Third. To arrest and take into custody any witness or witnesses to such unlawful dumping of prohibited material, the said witnesses to be released under proper bonds.

Accompanying towboats.

Fourth. To go on board of any towboat having in tow scows or boats loaded with such prohibited material, and accompany the same to the place of dumping, whenever such action appears to be necessary to secure compliance with the requirements of this Act and of the Act aforesaid.

Inspecting gas, etc., works.

Fifth. To enter gas and oil works and all other manufacturing works for the purpose of discovering the disposition made of sludge, acid, or other injurious material, whenever there is good reason to believe that such sludge, acid, or other injurious material is allowed to run into the tidal waters of the harbor in violation of section one of the aforesaid Act of June twenty-ninth, eighteen hundred and eighty-eight.

Penalty for bribing, etc.

Every person who, directly or indirectly, gives any sum of money or other bribe, present, or reward or makes any offer of the same to any inspector, deputy inspector, or other employee of the office of the supervisor of the harbor with intent to influence such inspector, deputy inspector, or other employee to permit or overlook any violation of the provisions of this section or of the said Act of June twenty-ninth, eighteen hundred and eighty-eight, shall, on conviction thereof, be fined not less than five hundred dollars nor more than one thousand dollars, and be imprisoned not less than six months nor more than one year.

Return of permits.

Every permit issued in accordance with the provisions of this section of this Act which may not be taken up by an inspector or deputy inspector shall be returned within forty-eight hours after issuance to the office of the supervisor of the harbor; such permit shall bear an indorsement by the master of the towboat, or the person acting in such capacity, stating whether the permit has been used, and if so the time and place of dumping. Any person violating the provisions of this section shall be liable to a fine of not more than five hundred dollars nor less than one hundred dollars.

Indorsement.

Penalty.

Use of canals, etc., to be regulated by Secretary of War.

SEC. 4. That it shall be the duty of the Secretary of War to prescribe such rules and regulations for the use, administration, and navigation of any or all canals and similar works of navigation that now are, or that hereafter may be, owned, operated, or maintained by the United States as in his judgment the public necessity may require.

Posting rules.

Such rules and regulations shall be posted, in conspicuous and appropriate places, for the information of the public; and every person and every corporation which shall knowingly and willfully violate such rules and regulations shall be deemed guilty of a misdemeanor and, on conviction thereof in any district court in the United States within whose territorial jurisdiction such offense may have been committed, shall be punished by a fine not exceeding five hundred dollars, or by imprisonment (in the case of a natural person) not exceeding six months, in the discretion of the court.

Drawbridges. Regulations for use to be published.

SEC. 5. That it shall be the duty of all persons owning, operating, and tending the drawbridges now built, or which may hereafter be built across the navigable rivers and other waters of the United States, to open, or cause to be opened, the draws of such bridges under such rules and regulations as in the opinion of the Secretary of War the public interests require to govern the opening of drawbridges for the passage of vessels and other water crafts, and such rules and regulations, when so made and published, shall have the force of law. Every such person who shall willfully fail or refuse to open, or cause to be opened, the draw of any such bridge for the passage of a boat or boats, or who shall unreasonably delay the opening of said draw after reasonable signal shall have been given, as provided in such regulations, shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine of not more than two thousand dollars nor less than one thousand dollars, or by imprisonment (in the case of a natural person) for not exceeding one year, or by both such fine and imprisonment, in the discretion of the court: *Provided*, That the proper action to enforce the provisions of this section may be commenced before any commissioner, judge, or court of the United States, and such commissioner, judge, or court shall proceed in respect thereto as authorized by law in case of crimes against the United States: *Provided further*, That whenever, in the opinion of the Secretary of War, the public interests require it, he may make rules and regulations to govern the opening of drawbridges for the passage of vessels and other water

Penalty for violations.

Provisos. Proceedings.

Secretary of War may make rules, etc.

crafts, and such rules and regulations, when so made and published, shall have the force of law, and any violation thereof shall be punished as hereinbefore provided.

Deposits of refuse, etc., in navigable waters forbidden.

SEC. 6. That it shall not be lawful to place, discharge, or deposit, by any process or in any manner, ballast, refuse, dirt, ashes, cinders, mud, sand, dredgings, sludge, acid, or any other matter of any kind other than that flowing from streets, sewers, and passing therefrom in a liquid state, in the waters of any harbor or river of the United States, for the improvement of which money has been appropriated by Congress, elsewhere than within the limits defined and permitted by the Secretary of War; neither shall it be lawful for any person or persons to move, destroy, or injure in any manner whatever any sea wall, bulkhead, jetty, dike, levee, wharf, pier, or other work built by the United States, in whole or in part, for the preservation and improvement of any of its navigable waters, or to prevent floods, or as boundary marks, tide gauges, surveying stations, buoys, or other established marks; any and every such act is made a misdemeanor, and every person knowingly engaged in or who shall knowingly aid, abet, authorize, or instigate a violation of this section shall, upon conviction, be punishable by fine or imprisonment, or both, such fine to be not less than two hundred and fifty dollars nor more than twenty-five hundred dollars, and the imprisonment to be not less than thirty days nor more than one year, either or both united, as the judge before whom conviction is obtained shall decide, one-half of said fine to be paid to the person or persons giving information which shall lead to conviction of this misdemeanor.

Injuries to jetties, etc., forbidden.

Penalties.

Masters, pilots, etc., injuring works, etc., to have licenses revoked or suspended.

SEC. 7. That any and every master, pilot, and engineer, or person or persons acting in such capacity, respectively, on board of any boat or vessel who may willfully injure or destroy any work of the United States contemplated in section six of this Act, or who shall knowingly engage in towing any scow, boat, or vessel loaded with any such prohibited matter to any point or place of deposit or discharge in any harbor contemplated in section six of this Act, elsewhere than within the limits defined and permitted by the Secretary of War, shall be deemed guilty of a violation of this Act and shall, upon conviction, be punishable as hereinbefore provided for offenses in violation of section six of this Act, and shall also have his license revoked or suspended for a term to be fixed by the judge before whom tried and convicted.

Libel against boats violating deposit, etc., prohibitions.

SEC. 8. Any boat, vessel, scow or other craft used or employed in violating any of the provisions of sections six and seven of this Act shall be liable to the pecuniary penalites imposed thereby, and in addition thereto to the amount of the damages done by said boat, vessel, scow, or other craft, which latter sum shall be placed to the credit of the appropriation for the improvement of the harbor in which the damage occurred, and said boat, vessel, scow, or other craft may be proceeded against summarily by way of libel in any district court of the United States having jurisdiction thereof.

Displacement of tide waters by piers, etc. Compensating basin.

SEC. 9. That whenever the Secretary of War grants to any person or persons permission to extend piers, wharves, bulkheads, or other works, or to make deposits in any tidal harbor or river of the United States beyond any harbor lines established under authority of the United States, he shall cause to be ascertained the amount of tide water displaced by any such structure or by any such deposits, and he shall, if he deem it necessary, require the parties to whom the permission is given to make compensation for such displacement either by excavating in some part of the harbor, including tide water channels between high and low water mark, to such an extent as to create a basin for as much tide water as may be displaced by such structure or by such deposits, or in any other mode that may be satisfactory to him: *Provided*, That all such dredging or other improvement shall be carried on under the direction of the Secretary of War, and shall in no wise injure any existing channels.

Proviso. Dredging.

Preliminary examinations.

SEC. 10. That the Secretary of War is hereby directed to cause preliminary examinations to be made at the following localities, to wit:

Arkansas.

ARKANSAS.

Little River, from Fulton to White Cliffs.

Bayou Macon above Floyd.

Boueff River above Wallaces Landing.

Cache River to Riverside, with a view to low-water navigation.

Upper White River, to determine the proper method of improvement.

Arizona.

ARIZONA.

Colorado River above Yuma to the highest point of navigation.

Connecticut.

CONNECTICUT.

Harbor of West Haven, and West River from the steam railroad crossing to the main channel of New Haven Harbor.

Black Rock Harbor.

Greenwich Harbor.

Byram Harbor.

California.

CALIFORNIA.

San Francisco Harbor, obstructions therein and in the approaches thereto, as follows: Noonday Rocks, Mile Rocks, the Sunken Rocks off Fort Point, Anita Rock, near Fort Point; Arch Rock, Shag Rock, Blossom Rock, Two Mission Rocks, Invincible Rock, one-half mile southerly from The Brothers light-house; Whiting Rock, one-eighth of a mile north of Invincible Rock, and Fifteen Feet Rock, a quarter of a mile west of said light-house, with a view to their removal.

San Rafael Creek and Mendocino Harbor.

Georgiana River.

San Joaquin River, above the mouth of Stanislaus River, with a view to improvement, including closure of sloughs to a height sufficient to maintain current in main channel during low-water period.

Feather River, above Marysville.

American River, with a view to prevention of sand flowing into the Sacramento River, near the city of Sacramento.

Harbor of El Moro.

Napa River, between North and South Vallejo, with a view of improvement and confinement of current to keep channel open.

Steamboat Channel, and from junction thereof with Sacramento River to mouth of said river, with a view to improvement, enlargement of navigable channel, and to increase capacity for flood discharge.

Suisun Creek, with a view to improvement of channel.

DELAWARE. Delaware.

Christiana River above Wilmington to Newport.

For a canal from Pocomoke River to Indian River.

Mouth of Broad Kiln River.

Mahon River.

MARYLAND. Maryland.

Harbor at Claiborne, the west terminus of the Baltimore and Eastern Shore Railroad.

Chapel Point Harbor, at the junction of the Potomac and Port Tobacco rivers, with a view to the improvement of said harbor and its approaches.

FLORIDA. Florida.

Tampa Bay, from Port Tampa to the mouth of the bay.

Crystal River, at its mouth.

Carabelle bar and harbor.

Saint Johns River, at Orange Mills Flats, near Palatka, and for the improvement of the channel of the Saint John's River to Sandford and points above with a view to obtaining sufficient water for sea going vessels.

Saint Lucia Inlet and River.

Withlacoochee River, from its month to head of navigation.

Entrance to Biscayne Bay.

Anclote River.

ILLINOIS. Illinois.

Quincy Bay.

KENTUCKY. Kentucky.

For ice harbor, including lock and dam, at a point about three miles from mouth of Licking River.

Louisiana.

LOUISIANA.

Bayou Teche, from Saint Martinsville to Port Barre.
Bayou Bonfuca, in Saint Tammany Parish.
Harbor at Baton Rouge.
Harbor at Bayou Sara.
Chefuncte River and Bogue Falia.
Tickfaw River and tributaries.
Bayou Dugdamona.
Bayou Castor.
Little River.

Massachusetts.

MASSACHUSETTS.

Manchester Harbor, from mouth of the river below the Point of Rocks, with a view to a channel one hundred feet wide and five feet deep, and removal of sand bar at mouth of river and removal of sand bar and rocks at the Point of Rocks.

Plymouth Harbor, with a view to the removal of the obstructions known as "Splitting Knife" and "Middle Ground," and the north and south sides of the excavated channel in said harbor with a view to deepening and improving the same.

Onset Harbor.
Bass River.
Hyannis Harbor.
Chatham New Harbor.
Mount Hope Bay and harbor of Fall River.
Byrams Cove Harbor.

Maine.

MAINE.

Glen Cove Harbor.
Parkers Head harbor and channel.
Royals River, from the village of Yarmouth to Casco Bay,
Harbor of Cape Porpoise.

Missouri.

MISSOURI.

Saint Francis River, from the Sunk Lands to Greenville, Missouri.

Michigan.

MICHIGAN.

Kalamazoo River, from its mouth to the city of Kalamazoo.

White Fish River, for a harbor at the mouth in Little Badenock Bay.

Clinton River.

Shiawassee River, from Saginaw River to Bad River; Bad River to village of Saint Charles; Flint River to head of navigation.

Kawkawlin River.

Tittabawassee River, from Saginaw to the head of navigation.

MINNESOTA.

Minnesota.

Big Stone Lake, with a view to construction of reservoirs.

Minnesota River, with a view to protecting the banks opposite the borough of Belle Plain, so as to prevent the river from cutting through the narrow neck of land at that point and with a view of protecting the banks at and near the city of Mankato.

Red Lake River, with the view of improving Red Lake River from Thief River Falls to the Red Lake.

MISSISSIPPI.

Mississippi.

Yallabusha River.

Noxubee River, from Macon to mouth of Hashuqua Creek.

Bogue Phalia, especially at the point known as "The Narrows."

Bear Creek, from where it empties into the Yazoo, up stream.

Big Sunflower River, with a view to its improvement as high as Clarksdale by locks and dams.

The bar recently formed in Horn Island Pass.

MONTANA.

Montana.

Flathead River, from Columbia Falls, in Montana, to its mouth at Flathead Lake, and from its outlet on the south at Flathead Lake to the Clarkes Fork of the Columbia River.

Kootenai River, from Jennings, in Montana, to the international boundary, with a view of removing rocks and obstructions in the canyon above the town of Jennings.

Pend d'Oreille River, from Flathead Lake to Jocko Station, Montana.

Tongue River, with a view of straightening its channel along the eastern edge of the Fort Keogh military reservation.

NEBRASKA.

Nebraska.

The Nebraska side of the Missouri River opposite Sioux City, Iowa from a point in Nebraska where an extension of the lower limits of Sioux City, Iowa, would intersect the Nebraska side of the river and up the river to a point in Nebraska opposite the mouth of Big Sioux River.

NEW YORK.

New York.

Echo Bay and New Rochelle Harbor.

Channel connecting Irondequoit Bay with Lake Ontario.

Port Chester.

Woodsburg Channel, in Hempstead Bay.

Carrls River.

West branch of Newton Creek, from Metropolitan Avenue bridge to the head of navigation.

Harbor of Waddington.
Harbor of Greenport.
Milton Harbor at Milton Point.
Gravesend Bay.
Dunkirk.
Cold Spring Harbor.
Hempstead Harbor.
Peekskill.

North Carolina.

NORTH CAROLINA.

Core Sound, from mouth of North River to Beaufort Harbor, and Cape Lookout Harbor of Refuge, with a view to improvement of navigation.

Drum Inlet, between Portsmouth and Cape Lookout.

Tar River, from Washington to Greenville, with a view to obtaining a depth of three feet.

South Creek, from mouth to head of navigation.

Turners Cut, a branch of Pasquotank River.

Scuppernong River.

New Jersey.

NEW JERSEY.

Mantua Creek.
Buckshutem.
Cold Spring Inlet.
Rancocas River.

Inside of Absecon Inlet, near the southwesterly point of Brigantine Beach, with a view to uniting the waters of that part of the water bed known as the "main channel," now flowing under or along Bringantine Beach, with said water bed now flowing under or along Rum Point, and with the waters of Absecon Channel, so as to improve and shorten steamboat or ferry navigation between the termini of railroad transportation at Atlantic City and Brigantine Beach.

Delaware River, between Trenton and Burlington, for improvement of river and protection of banks.

Inlet at mouth of Shark River, for harbor of refuge.

Elizabeth River, to report upon the desirability of placing locks in the mouth of said river, and the cost of same.

The Lumberton branch of the Rancocas River as far as Lumberton.

Salem River from the mouth of said river as far as Salem City.

Rahway River, to report upon the desirability of placing locks in the mouth of said river and the cost of same.

Ohio.

OHIO.

Ironton, with a view of protecting the Ohio River front within the limits of the city.

Oregon.

OREGON.

Yaquina Bay Bar, for increased depth.

Tualiton River to Hillsboro, and to the head of navigation.

Clatskanie River, from mouth to town of Clatskanie.
Umpqua River, from Scottsburg to Elkton Rapids.

PENNSYLVANIA. Pennsylvania.

Clarion River.
Tionesta River.
Susquehanna River between Nanticoke and Pittston.

RHODE ISLAND. Rhode Island.

Connanicut Island, with a view of cutting a channel through the same.
Seaconnet Point.
Stone Bridge over Seaconnet River to ascertain the cost of widening and deepening the passage at the draw of said bridge to the same extent as prescribed in the recent order of the Secretary of War, respecting the railroad bridge across said river, and the Secretary of War is directed to prepare and submit to Congress an estimate of the cost of such work.

TENNESSEE. Tennessee.

Wolf River, from its mouth to a point five miles above.

TEXAS. Texas.

Channel through Sabine Lake, from the mouth of the Sabine and Neches rivers to the head of the pass from said lake to the Gulf of Mexico.
Brazos River, from the city of Waco to the town of Richmond.
Bar and Harbor at Brazos Santiago.
Colorado River from the mouth to the city of Wharton.
Guadalupe River from its mouth to the city Cuero.

VIRGINIA. Virginia.

Deep Creek branch of Elizabeth River, with a view of obtaining a depth equal to that of the Lake Drummond Canal, formerly the Dismal Swamp Canal, and the western branch of the said Elizabeth River.
Harris Creek prong of Back River.
Lyons Creek.
For internal waterway, extending from Franklin city southward to Cape Charles. The chief obstructions exist in what is known as Boggs Bay, Cat Creek, Kegotank Bay, Weir Passage, and Burtons Bay.
Jacksons Creek, near mouth of Piankatank River.
Ware River.
Quantico Creek.
Great Wicomico River, from Cedar Point to Indian Point.
Little Wicomico River, at its mouth.
Hunting Creek from its mouth to head of navigation.

Vermont.

VERMONT.

Missisquoi River, particularly between the village of Swanton and the lake.

Washington.

WASHINGTON.

North River, from its mouth in Wallapa Bay, upward twenty-five miles.

Quillayute Harbor and River.

Okanagon River, from mouth to head of navigation.

Bellingham Bay.

Clallam Bay, with a view to its improvement as a harbor of refuge.

Lewis River, from La Center to its mouth, with a view of deepening the channel and improving the navigation.

From Hood's Canal in Puget Sound to North Bay in said sound, with a view of constructing a water way and channel between the two bodies of water at the most practicable place, of sufficient depth to be navigable for all classes of vessels.

Wisconsin.

WISCONSIN.

Mouth of Iron River, Lake Superior.

Flag Lake and mouth of Flag River.

La Cross Harbor, for removal and prevention of bar.

Oconto River, to obtain a channel sixteen feet deep and one hundred and fifty feet wide.

Harbors of Superior, Wisconsin, and Duluth, Minnesota, with a view of deeping said harbors and entrances thereto to twenty feet.

West Virginia.

WEST VIRGINIA.

Little Kanawha River, with a view of improvement by locks and dams, including an estimate of the probable cost to the Government of each lock and dam now in existence on said river and not owned by the Government.

Guyandotte River, with a view of improvement by locks and dams.

Big Coal River.

Little Coal River.

Elk River, with a view of locking and damming same.

Making preliminary examinations.

SEC. 11. That the preliminary examinations ordered in this act shall be made by the local engineer in charge of the district, or an engineer detailed for the purpose; and such local or detailed engineer and the division engineer of the locality shall report to the Chief of Engineers, first, whether, in their opinion, the harbor or river under examination is worthy of improvement by the General Government, and shall state in such report fully and particularly the facts and reasons on which they base such opinions, including the present and prospective demands of commerce, and, second, if worthy of improvement by the General Government, what it will cost to survey the same, with the view of submitting plan and estimate for its

Report to Chief of Engineers.

improvement; and the Chief of Engineers shall submit to the Secretary of War the reports of the local and division engineers, with his views thereon and his opinion of the public necessity or convenience to be subserved by the proposed improvement; and all such reports of preliminary examinations, with such recommendations as he may see proper to make, shall be transmitted by the Secretary of War to the House of Representatives, and are hereby ordered to be printed when so made.

Report to Secretary of War.

Report to House of Representatives to be printed.

SEC. 12. That the Secretary of War is hereby directed, at his discretion, to cause surveys to be made and the cost of improvement to be estimated at the following localities, to wit:

Surveys and estimates ordered.

CALIFORNIA.

California.

Old River Branch of San Joaquin River.
Crescent City Harbor.

CONNECTICUT.

Connecticut.

Westport Harbor.
Norwalk Harbor.
Stonington Harbor.

DELAWARE.

Delaware.

Nanticoke River, in Delaware.

FLORIDA.

Florida.

Canaveral Harbor.

Saint John's River from Jacksonville to the ocean. The Secretary of War is hereby directed to prepare and submit plans and estimates for continuing the work, with a view to secure an increase of the depth of the channel to twenty-four feet.

GEORGIA.

Georgia.

Savannah River, between Spirit Island and the point where the Charleston and Savannah Railroad crosses said river. The Secretary of War is hereby directed to cause the project to be prepared and an estimate of cost of improvement of this locality to be made.

IDAHO.

Idaho.

The Secretary of War is hereby directed to prepare and submit plans and estimates for the improvement of the Kootenai River, Idaho, as recommended by Captain Symonds in the preliminary examination submitted by him under date of October twelfth, eighteen hundred and ninety-two.

INDIANA.

Indiana.

Harbor of Evansville.

Illinois.

ILLINOIS.

Harbor of Elizabethtown.

Maine.

MAINE.

Georges River, from Thomaston to mouth.
Carvers Harbor.
Machias River Channel, and Sasanoa River, from Bath to Boothbay.

Maryland.

MARYLAND.

Pocomoke River, with a view of uniting the waters of said river with the waters of Sinepuxent Bay, at a point above Snow Hill, and of improving said river between Snow Hill and Shad Landing.
Rock Hall Harbor.
Baltimore Harbor, to widen the ship channel to one thousand feet.

Massachusetts.

MASSACHUSETTS.

Chelsea River, from Grand Junction Railroad bridge to Boston and Maine Railroad bridge.
East Boston Channel.
Tarpaulin Cove, Naushon Island.
Woods Holl, and Little Woods Holl Harbor.

Michigan.

MICHIGAN.

Belle River.
Sebewaing River.
Pine River, at Saint Clair City, Michigan. The Secretary of War is directed to cause the project to be prepared and an estimate of the cost of the improvement of this locality to be made.

New Jersey.

NEW JERSEY.

Cooper Creek.
Dennis Creek.

North Carolina.

NORTH CAROLINA.

North East (Cape Fear) River, from the old County Ferry to Juniper Swamp, or Creek, a point about one mile north of Hilton railroad bridge, with a view to obtaining an increased depth of channel.
Alligator River.
Cape Fear River, above Fayetteville.

Oregon.

OREGON.

Coos River.
Yam Hill River, up to town of McMinnville, with a view of improving the same by locks or dams or otherwise.
Columbia River, below Tongue Point, by way of the southern channel in front of Astoria.
Willamette River, from Portland to Eugene.
Alsea River.
Nestucca River, from town of Woods to the ocean.

Port Orford, with a view to improving the same for shipping purposes and as a harbor of refuge, commencing at Graveyard Point and by jetty, sea wall, or other proper construction extending southerly or southeasterly into the ocean three hundred or more feet, if necessary, and suitable for vessels of middle draft; and, secondly, if necessary, by another jetty, sea wall, or other constructive work, extending from the next high point or headland southwesterly four hundred or more feet, so as to accommodate vessels of maximum draft.

PENNSYLVANIA.

Pennsylvania.

Allegheny River, for lock and dam at or near Tarentum, and lock and dam at the most practicable point for navigation between the proposed dam at Tarentum and Herrs Island Dam.

Ohio River, movable dams, numbered three, four, and five.

RHODE ISLAND.

Rhode Island.

Wickford Harbor, in Narragansett Bay.

Great Salt Pond, Block Island, with a view to making harbor of refuge therein.

Paweatuck River, with reference to its further imprcvement from Westerly, Rhode Island, to Stonington, Connecticut.

SOUTH CAROLINA.

South Carolina.

Steamboat Channel, seven feet deep at mean low water, between Beaufort, South Carolina, and Savannah, Georgia.

TENNESSEE.

Tennessee.

Forked Deer River from Dyersburg, Tennessee, to its junction with the Obion River, and thence to the Mississippi River, so as to make said stream navigable all the year.

TEXAS.

Texas.

Brazos River from the town of Velasco to the town of Richmond.

For determining the causes of the erosion of the easterly end of Galveston Island, and estimating the cost of works to prevent the same.

VIRGINIA.

Virginia.

Bar at the northwest entrance of Milford Haven from Piankatank River.

Mouth of Cranes Creek, a tidal estuary of Great Wicomico River.

WASHINGTON.

Washington.

Columbia River, from Rock Island Rapids to the Okanogan River.

Nootsack River.

Grays Harbor and its bar entrance, with a view to the improvement of its channels.

Wisconsin.

WISCONSIN.

Alouez Bay.

Appropriation for preliminary examinations, surveys, etc.

SEC. 13. For preliminary examinations, surveys, except where otherwise herein especially provided for, contingencies, expenses connected with inspection of bridges, the service of notice required in such cases, the examination of bridge sites and reports thereon, and for incidental repairs for which there is no special appropriation for rivers and harbors, one hundred and twenty-five thousand dollars: *Provided*, That no preliminary examinations, survey, project, or estimate for new works other than those designated in this Act shall be made: *And provided further*, That after the regular or formal report on any examination, survey, project, or work under way or proposed is submitted, no supplemental or additional report or estimate, for the same fiscal year, shall be made unless ordered by a resolution of Congress. The Government shall not be deemed to have entered upon any project for the improvement of any waterway or harbor mentioned in this Act until funds for the commencement of the proposed work shall have been actually appropriated by law.

Provisos.

Restriction.

Additional reports forbidden.

No project authorized until appropriated for.

Received by the President, August 7, 1894.

[NOTE BY THE DEPARTMENT OF STATE.—The foregoing act having been presented to the President of the United States for his approval, and not having been returned by him to the house of Congress in which it originated within the time prescribed by the Constitution of the United States, has become a law without his approval.]

August 18, 1894.

CHAP. 301.—An Act Making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, and for other purposes.

Sundry civil expenses appropriations.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, for the objects hereinafter expressed, for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, namely:

* * * * * * *

War Department.

UNDER THE WAR DEPARTMENT.

* * * * * * *

Buildings and grounds, D. C.

BUILDINGS AND GROUNDS IN AND AROUND WASHINGTON.

Improvement and care.

For the improvement and care of public grounds as follows:

For improvement of grounds north and south of Executive Mansion, five thousand dollars.

For ordinary care of greenhouses and nursery, two thousand dollars.

For ordinary care of Lafayette Square, one thousand dollars.

For ordinary care of Franklin Square, one thousand dollars.

For ordinary care of Lincoln Square, one thousand dollars.

For care and improvement of Monument grounds, two thousand dollars.

For continuing improvement of reservation numbered seventeen and site of old canal northwest of same, three thousand dollars: *Provided*, That no part thereof shall be expended upon other than property belonging to the United States. Old canal, etc. *Proviso.*

For construction and repair of post-and-chain fences, repair of high iron fences, and constructing stone coping around reservations, one thousand five hundred dollars.

For manure, and hauling the same, four thousand dollars.

For painting watchmen's lodges, iron fences, vases, lamps, and lamp-posts, one thousand dollars.

For purchase and repair of seats, one thousand dollars.

For purchase and repair of tools, two thousand dollars.

For trees, tree and plant stakes, labels, lime, whitewashing, and stock for nursery, trees and stock for nursery to be purchased by contract or otherwise, as the Secretary of War may determine, two thousand dollars.

For removing snow and ice, one thousand two hundred dollars.

For flowerpots, twine, baskets, wire, splints, moss, and lycopodium, one thousand dollars.

For care, construction, and repair of fountains, one thousand five hundred dollars.

For abating nuisances, five hundred dollars.

For improvement, care, and maintenance of various reservations, ten thousand dollars.

For improvement, maintenance, and care of Smithsonian Grounds, two thousand five hundred dollars.

For improvement, care, and maintenance of Judiciary Square, two thousand five hundred dollars.

That under appropriations herein contained no contract shall be made for making or repairing concrete or asphalt pavements in Washington City at a higher price than two dollars and twenty-five cents per square yard for a quality equal to the best laid in the District of Columbia prior to July first, eighteen hundred and eighty-six, and with a base of not less than six inches in thickness. Limit for concrete pavements.

For replacing the old flagging pavement of the sidewalks in the grounds north of the Executive Mansion by a granolithic pavement, two thousand five hundred dollars.

For repairs and fuel at the Executive Mansion, as follows: Executive Mansion.

For care, repair, and refurnishing the Executive Mansion, twenty-five thousand dollars, to be expended by contract or otherwise, as the President may determine. Repairs, fuel, etc.

For fuel for the Executive Mansion, greenhouses, and stable, three thousand dollars.

For care and necessary repair of greenhouses, four thousand dollars.

For renewing the superstructure of one greenhouse connected with the Executive Mansion, one thousand five hundred dollars.

For repairs to conservatory, Executive Mansion, two thousand dollars.

Portrait of ex-President Benjamin Harrison.

For portrait and frame for same of Honorable Benjamin Harrison, ex-President of the United States, two thousand five hundred dollars.

Lighting Executive Mansion and public grounds.

LIGHTING THE EXECUTIVE MANSION AND PUBLIC GROUNDS: For gas, pay of lamp-lighters, gas fitters, and laborers; purchase, erection, and repair of lamps and lampposts; purchase of matches, and for repairs of all kinds; fuel and lights for office, office stables, watchmen's lodges, and for the greenhouses at the nursery, fourteen thousand dollars: *Provided*, That for each six foot burner not connected with a meter in the lamps on the public grounds no more than twenty dollars and fifty cents shall be paid per lamp for gas, including lighting, cleaning, and keeping in repair the lamps, under any expenditure provided for in this Act; and said lamps shall burn not less than three thousand hours per annum; and authority is hereby given to substitute other illuminating material for the same or less price, and to use so much of the sum hereby appropriated as may be necessary for that purpose: *Provided*, That before any expenditures are made from the appropriations herein provided for, the contracting gas company shall equip each lamp with a self-regulating burner and tip, so combined and adjusted as to secure under all ordinary variations of pressure and density a consumption of six cubic feet of gas per hour.

Provisos.

Maximum per lamp.

Burners.

Electric lights.

For electric lights for three hundred and sixty-five nights from seven posts, at thirty cents per light per night, seven hundred and sixty-six dollars and fifty cents.

Repair of water pipes, etc.

REPAIR OF WATER PIPES: For repairing and extending water pipes, purchase of apparatus for cleaning them, purchase of hose, and cleaning the springs and repairing and renewing the pipes of the same that supply the Capitol, the Executive Mansion, and the building for the State, War, and Navy Departments, two thousand five hundred dollars: *Provided*, That the Secretary of War and the Attorney-General are hereby authorized to investigate and ascertain what action has been taken by them or their predecessors in office, or by any Secretary of the Interior, under the Act of July fifteenth, eighteen hundred and eighty-two, entitled "An Act to increase the water supply of the city of Washington," and under any previous Acts; and also the existing claims, if any, of the State of Maryland, the Chesapeake and Ohio Canal Company, the Great Falls Manufacturing Company, and any other owner of land and water rights, or either, at the Great Falls; and also, further, the cost of acquiring the title or titles to such lands and water rights, or either, as may be necessary to

Proviso.

Investigation of water rights, etc.

Vol. 22, p. 168.

vest in the Government complete ownership of the water rights and necessary lands, and to make a full report of all the facts to Congress; and the sum of four thousand dollars, or so much thereof as may be necessary, is hereby appropriated for such investigation, examination, and report.

TELEGRAPH TO CONNECT THE CAPITOL WITH THE DEPARTMENTS AND GOVERNMENT PRINTING OFFICE: For care and repair of existing lines, one thousand two hundred and fifty dollars.

Telegraph, Capitol, Departments, and Printing Office.

WASHINGTON MONUMENT: For the care and maintenance of the Washington Monument, namely: For one custodian, at one hundred dollars per month; one steam engineer, at eighty dollars per month; one assistant steam engineer, at sixty dollars per month; one fireman, at fifty dollars per month; one assistant fireman, at forty-five dollars per month; one conductor of elevator car, at seventy-five dollars per month; one attendant on floor, at sixty dollars per month; one attendant on top floor, at sixty dollars per month; three night and day watchmen, at sixty dollars per month each; in all eight thousand five hundred and twenty dollars.

Washington Monument.

Care and maintenance.

For fuel, lights, oil, waste, packing, tools, matches, paints, brushes, brooms, lanterns, rope, nails, screws, lead, electric lights, heating apparatus, oil stoves for elevator car and upper and lower floor, repairs to engines, boilers, dynamos, elevator, and repairs of all kinds connected with the monument and machinery, and purchase of all necessary articles for keeping the monument, machinery, elevator, and electric-light plant in good order, three thousand dollars.

Expenses.

For one new engine, complete, in position, to replace the old engine which runs the dynamo for the electric lights, six hundred and fifty dollars.

New engine.

* * * * * * *

ENGINEER DEPARTMENT.

Engineer Department.

For continuing improvement of harbor at Philadelphia, Pennsylvania: Continuing improvement, removal of Smiths Island and Windmill Island, Pennsylvania, and Petty Island, New Jersey, and adjacent shoals, two hundred and fifty thousand dollars.

River and harbor improvements.

Philadelphia, Pa.

For improving harbor at Galveston, Texas: Continuing improvement, six hundred thousand dollars, one hundred thousand dollars of which may be expended for dredging, under the direction of the Secretary of War, by contract or otherwise, as may be most economical and advantageous to the United States.

Galveston, Tex.

For improving Hay Lake Channel, Saint Marys River, Michigan: Continuing improvement, one hundred and fifty thousand dollars.

Hay Lake channel, St. Marys River, Mich.

For improving Hudson River, New York: Continuing improvement one hundred and forty-five thousand dollars.

Hudson River, N. Y.

For improving Mississippi River from the mouth of the Ohio River to the landing on the west bank below the

Mississippi River, mouth of the Ohio to Minneapolis, Minn.

Washington avenue bridge, Minneapolis, Minnesota: Continuing improvement from the mouth of the Ohio River to the mouth of the Missouri River, seven hundred and fifty-eight thousand three hundred and thirty-three dollars and thirty-three cents; continuing improvement from the mouth of Missouri River to Minneapolis, eight hundred and sixty-six thousand six hundred and sixty-six dollars and sixty-seven cents; in all, one million six hundred and twenty-five thousand dollars.

St. Marys River at the Falls, Mich.

For improving Saint Marys River at the Falls, Michigan: Continuing improvement, three hundred thousand dollars.

Point Judith, R. I.

For harbor of refuge at Point Judith, Rhode Island: Continuing improvement, one hundred thousand dollars.

Charleston, S. C.

For improving harbor at Charleston, South Carolina, including Sullivan Island and Mount Pleasant Shore: Continuing improvement, four hundred and fifty thousand dollars.

Savannah, Ga.

For improving harbor at Savannah, Georgia: Continuing improvement, nine hundred and seventy-five thousand dollars.

Mobile, Ala.

For improving harbor at Mobile, Alabama: Continuing improvement, three hundred and ninety thousand dollars.

Mississippi River Commission.

Mississippi River.

Under Mississippi River Commission: For improving Mississippi River from Head of the Passes to the mouth of the Ohio River, including salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission, two million six hundred and sixty-five thousand dollars.

Missouri River Commission.

Missouri River.

Under Missouri River Commission: For improving Missouri River from its mouth to the south line of Sioux City, Iowa, including salaries, clerical, office, traveling, and miscellaneous expenses of the Missouri River Commission, surveys, permanent bench marks and gauges, seven hundred and fifty thousand dollars, fifty thousand dollars of which may be used for removal of snags and other like obstructions in the Missouri River above Sioux City, Iowa, from the south line thereof, to be expended under the direction of the Secretary of War.

* * * * * * *

Miscellaneous objects.

MISCELLANEOUS OBJECTS.

Survey of northern, etc., lakes.

SURVEY OF NORTHERN AND NORTHWESTERN LAKES: For printing and issuing charts for use of navigators and electrotyping plates for chart printing, two thousand dollars.

For surveys, additions to, and correcting engraved plates, to be available until expended, twenty-five thousand dollars.

Transporting maps.

TRANSPORTATION OF REPORTS AND MAPS TO FOREIGN COUNTRIES: For the transportation of reports and maps to foreign countries through the Smithsonian Institution, one hundred dollars.

* * * * * * *

New York Harbor.

HARBOR OF NEW YORK: For prevention of obstructive and injurious deposits within the harbor and adjacent waters of New York City.

For pay of inspectors and deputy inspectors, office force, and expenses of office, fifteen thousand dollars; Inspectors, etc.

For pay of crew and maintenance of steamer Argus, eight thousand dollars; Steamers, etc.

For pay of crew and maintenance of steamer Nimrod, eight thousand dollars.

For purchase or construction of one steam tug, forty-five thousand dollars, or so much thereof as may be necessary,

In all, seventy-six thousand dollars.

* * * * * * *

UNDER LEGISLATIVE.

Legislative.

* * * * * * *

BUILDING FOR THE LIBRARY OF CONGRESS.

Library of Congress.

For continuing the construction of the building for the Library of Congress, and for each and every purpose connected with the same, seven hundred thousand dollars: *Provided*, That contracts may be entered into for any work or materials required for the construction of said building, not to exceed two hundred thousand dollars, to be paid for as appropriations may from time to time be made by law; and the officer in charge of said building is hereby directed to report to Congress at its next session plans and estimates of cost for a tunnel, with suitable conveying apparatus for the rapid transmission of books, papers, and messages at all times between the said building and the Senate and House wings of the Capitol.

Continuing construction.

Proviso.

Contracts authorized.

Report on tunnel.

* * * * * * *

PUBLIC PRINTING AND BINDING.

Public printing and binding.

* * * * * * *

and the heads of the Executive Departments, before transmitting their annual reports to Congress, the printing of which is chargeable to this appropriation, shall cause the same to be carefully examined, and shall exclude therefrom all matter, including engravings, maps, drawings, and illustrations, except such as they shall certify in their letters transmitting such reports to be necessary and to relate entirely to the transaction of public business;

* * * * * * *

GOVERNMENT PRINTING OFFICE.

Government Printing Office.

To enable the Chief of Engineers of the Army, under the direction of the Joint Committee on Printing, to repair the Government Printing Office, provide fire escapes, and put said building in a safe and secure condition, and to enable the Public Printer, under the direction of the Joint Committee on Printing, to rent, if necessary, any buildings for use of the printing office, seventy-five thousand dollars.

Repairs, fire escapes, etc.

* * * * * * *

Approved, August 18, 1894.

August 23, 1894.

CHAP. 309.—An Act Extending the time for the completion of a railroad bridge over the Columbia River at or near Vancouver, in the State of Washington.

Bridge across Columbia River, Vancouver, Wash.

Time of completion extended. Vol. 26, p. 369.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the time for the completion of the bridge across the Columbia River at or near Vancouver, in the State of Washington, under the Act of Congress approved August twenty-ninth, eighteen hundred and ninety, entitled "An Act to authorize the construction of a bridge across the Columbia River by the Oregon Railway Extensions Company," be, and the same is hereby, extended until the fifteenth day of April, eighteen hundred and ninety-eight.

Approved, August 23, 1894.

August 23, 1894.

CHAP. 312.—An Act To authorize the construction of a bridge across the Contentnea Creek, at Grifton, Lenoir County, North Carolina, and to establish it as a post road.

Wilmington and Weldon Railroad Company may bridge Contentnea Creek, Grifton, N. C.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be lawful for the Kinston Branch of the Wilmington and Weldon Railroad Company, a corporation organized under the laws of the State of North Carolina, or its successors or assigns, to construct a bridge across the Contentnea Creek, at or near the town of Grifton, in the county of Lenoir and State of North Carolina; that said bridge may be constructed for railway, wagon, and postal service, with single or double track, for railway traffic, and shall be constructed under the conditions and limitations hereinafter specified.

Railway and wagon bridge.

Free navigation.

SEC. 2. That said bridge shall not interfere with the free navigation of said river beyond what may be necessary to carry into effect the rights and privileges herein granted, and in case of any litigation arising under the provisions of this act such litigation may be tried and determined by the circuit court of the United States within whose jurisdiction said bridge is located.

Litigation.

Draw.

SEC. 3. That the bridge hereby authorized to be constructed must be constructed with a draw of such dimensions and character as shall be prescribed by the Secretary of War.

Lawful structure and post route.

SEC. 4. That any bridge constructed under this Act shall be a lawful structure, and shall be known as a post road, over which no higher charge shall be made for the transmission of mails, troops, and munitions of war of the Government of the United States or for passenger or freight passing over the same than the rate per mile charged for their transportation over the railroad or public highways leading to the said bridge, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies. The United States shall also have the right of way over said bridge for postal-telegraph purposes.

Postal telegraph.

SEC. 5. That all railway companies desiring to use said bridge shall be entitled to equal rights and privileges in using the same, including the machinery and fixtures thereto belonging, and also the approaches thereto, upon such terms and conditions as shall be prescribed by the Secretary of War upon hearing the allegations and proofs of the parties in interest, in case they shall not be able to agree upon such terms and conditions.

Use by other companies.

Terms.

SEC. 6. That the said railway company, before entering upon the construction of said bridge, shall submit to the Secretary of War plans and drawings of said structure, together with a map of the location thereof, giving the topography of the banks of the river, the shore lines at high and low water, showing the bed of the river and the channel, with such other and further information as the Secretary of War may require; which said drawings and information aforesaid shall be examined by him, and if he shall approve the same he shall so notify the said railway company of such approval, and thereupon said company may proceed to the erection of said bridge. The Secretary of War may direct such alterations in such plans as he may deem necessary to the better protection of navigation, and such alterations shall be adopted by the said railway company. The said railway company may at any time make any alterations deemed advisable to be made in said bridge, but must first submit such proposed alterations to the Secretary of War, and his approval shall be first had before they shall be authorized or made.

Secretary of War to approve plans, etc.

Alterations.

SEC. 7. That the said bridge herein authorized to be constructed shall be so kept and managed at all times as to afford proper ways and means for the passage of vessels, barges, or rafts under it both by day and night. There shall be displayed on said bridge from sunset to sunrise such lights and signals as may be directed by the Light-House Board, and such changes may be made from time to time in the structure of said bridge as the Secretary of War may direct, at the expense of said railway, in order the more effectually to preserve the free navigation of said river, or the said structure shall be altogether removed, if, in the judgment of the Secretary of War, the public good may require such removal, and without expense or charge to the United States.

Aids to navigation.

Lights, etc.

SEC. 8. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within thirty days and completed within ninety days from the date of the approval of this Act.

Commencement and completion.

SEC. 9. That the right to alter, amend, or repeal this Act is hereby specially reserved.

Amendment, etc.

Approved, August 23, 1894.

August 23, 1894.

CHAP. 315.—An Act To repeal House Resolution numbered one hundred and four, first session Fifty-first Congress, granting to Secretary of War a permit to license to use a pier at mouth of Chicago River.

Chicago, Ill. Licenses of pier revoked.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That House Resolution numbered one hundred and four, first session of the Fifty-first Congress, approved October first, eighteen hundred and ninety, entitled "Joint Resolution to permit the Secretary of War to grant a revocable license to use a pier as petitioned by vessel owners of Chicago, Illinois," be, and the same is hereby repealed, and the property mentioned in the said joint resolution, to wit, the south pier of the Chicago River, shall be excepted from the provisions of an Act entitled "An Act authorizing the Secretary of War to lease public property in certain cases," approved July twenty-eighth, eighteen hundred and ninety-two, and said pier shall not be subject to be leased by the Secretary of War: *Provided*, That nothing herein contained shall be so construed as to abrogate the permit already granted by the Secretary of War to the Western Seamen's Friend Society for the use of a part of the said pier.

Vol. 27, p. 321.

Proviso. Exception.

Approved, August 23, 1894.

August 23, 1894.

CHAP. 317.—An Act To amend an Act entitled "An Act to incorporate the Washington and Great Falls Electric Railway."

Washington and Great Falls Electric Railway Company, D. C. Charter amended.

Vol. 27, p. 326.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Act of Congress entitled "An Act to incorporate the Washington and Great Falls Electric Railway Company," approved July twenty-ninth, anno Domini eighteen hundred and ninety-two, be, and the same is hereby, amended

* * * * * * *

Expenses of changes, water mains, etc.

SEC. 4. That the street-railway companies mentioned in this act, and hereafter all street-railway companies in the District of Columbia, respectively, shall bear all the expenses that may be incurred by the United States in making and inspecting such changes to the water mains, fixtures, or apparatus of the Washington Aqueduct as may be rendered necessary by the construction or extension of such several roads; and the Secretary of War is hereby authorized and directed to make all regulations to carry into effect the provisions of this section.

* * * * * * *

Amendment, etc.

SEC. 6. That Congress reserves the right at any time to alter, amend, or repeal this act.

Approved, August 23, 1894.

CHAP. 318.—An Act To authorize the Washington Alexandria and Mount Vernon Electric Railway Company to extend its line of road into and within the District of Columbia, and for other purposes.

August 23, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Washington, Alexandria and Mount Vernon Electric Railway Company, a body incorporated under the laws of the State of Virginia, be, and is hereby, authorized to construct and lay down a double-track street railway, except as hereinafter provided,

Washington, Alexandria and Mount Vernon Electric Railway Company may lay tracks, etc., D. C.

* * * * * * *

And the said Washington, Alexandria and Mount Vernon Electric Railway Company is hereby authorized and empowered to construct and maintain, after acquiring title to the same, at the foot of Fourteenth street, a necessary landing and slip for the operation of a ferryboat or transfer steamer, said landing and slip to be constructed on plans approved by the Secretary of War, and for the purpose of connection to use an overhead wire for a distance of not exceeding four hundred feet, commencing at the extreme southern end of the slip.

Ferry slip.

Overhead wire.

* * * * * * *

SEC. 8. That the said company shall, before commencing work on said railroad on such street, deposit with the Treasurer of the United States to the credit of the Washington Aqueduct such sum as the Secretary of War may consider necessary to defray all the expenses that may be incurred by the United States in connection with the inspection of the work of construction of said railroad on such street, and in making good any damages done by said company, or its works, or by any of its contracting agents, to any of said mains, fixtures, or apparatus, and in completing, as the Secretary of War may consider necessary, any of the work that the said company may neglect or refuse to complete, and that the Secretary of War may consider necessary for the safety of said mains, fixtures, or apparatus, and the said company shall also deposit as aforesaid such further sums for said purposes at such times as the Secretary of War may consider necessary: *Provided*, That the said sum shall be disbursed like other moneys appropriated for the Washington Aqueduct, and that whatever shall remain of said deposits at the end of one year after the completion of said railroad in such street shall be returned to said company on the order of the Secretary of War, with an account of its disbursement in detail: *And provided also*, That disbursements of said deposits shall, except in cases of emergency, be made only on the order of the Secretary of War. The exercise of the rights by this Act granted are to terminate at the pleasure of the Secretary of War in case of persistent neglect by said company, or by its successors, to make the deposits, or to comply with any of the conditions, requirements, and regulations aforesaid.

Deposit for expenses of inspection, etc.

Provisos. Disbursement.

Return of balance.

Neglect, etc., to terminate rights.

* * * * * * *

Proviso. Restrictions, etc.

SEC. 22. * * * *Provided*, That the limitations, requirements, and restrictions imposed by this Act upon the Washington, Alexandria and Mount Vernon Electric Railway Company shall apply to the Falls Church and Potomac Railway Company; and the said Falls Church and Potomac Railway Company shall be subject, in case of any violation of the limitations, requirements, and restrictions aforesaid, to the same fines, penalties, and forfeiture of the privileges and rights herein granted as the Washington, Alexandria and Mount Vernon Electric Railway Company is subject to.

* * * * * * *

Conditions, etc., binding on assigns.

SEC. 24. That all the conditions, requirements, and obligations imposed by the terms of this Act upon the Washington, Alexandria and Mount Vernon Electric Railway Company shall be complied with by any and all the successors to and assigns of said company.

Amendment, etc.

SEC. 25. That this Act may at any time be altered, amended, or repealed by the Congress of the United States.

Approved, August 23, 1894.

August 23, 1894.

CHAP. 320.—An Act To authorize the Saint Louis, Avoyelles and Southwestern Railway Company to bridge Bayou Des Glaises and Atchafalaya River in the State of Louisiana.

St. Louis, Avoyelles and Southwestern Railway Company may bridge Bayou Des Glaises and Atchafalaya River, La.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Saint Louis, Avoyelles and Southwestern Railway Company, its successors or assigns, be, and is hereby, authorized to construct and maintain a railway bridge and approaches thereto over and across Bayou Des Glaises, in the parish of Avoyelles, State of Louisiana, and also a railway bridge and approaches thereto over and across the Atchafalaya River, between Melville and the mouth of Red River, in said State, at such point as may be selected by said railway company for crossing said bayou and river with its railroad line, subject to the approval of the Secretary of War.

Railway, wagon, and footbridges.

Said bridges shall be constructed to provide for the passage of railway trains, and, at the option of said company, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for such reasonable rates of toll as may be approved from time to time by the Secretary of War.

Toll.

Draw piers.

That the bridges over said streams shall be constructed as draw or pivot bridges; the draw or pivot pier shall be over the main channel of the stream at an accessible navigable point, and the openings on each side of the pivot pier shall not be less than one hundred feet in the clear, unless otherwise expressly directed by the Secretary War, and if so directed shall be according to such direction, and the said openings shall be accessible at all stages of water, and the spans shall be not less than ten feet above extreme high water, as understood at the point of location, to the lowest part of the superstructure of the bridge, and the

piers and draw rests shall be parallel with, and the bridge or bridges at right angles to, the current of the stream or streams, and no riprap or other outside protection for imperfect foundations shall be permitted to approach nearer than four feet to the surface of the water at its extreme low stage, or otherwise to encroach upon the channel ways provided for in this Act; and all and each of said draws shall be opened promptly upon reasonable signals for the passage of boats; and said company shall maintain, at its own expense, from sunset till sunrise, throughout the season of navigation, such lights or other signals on said bridges as the Light-House Board may prescribe. Lights, etc.

SEC. 2. That any bridge built under this Act, and subject to its limitations, shall be a lawful structure, and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge; and it shall enjoy the rights and privileges of other post roads in the United States. Lawful structures and post routes.

SEC. 3. That no bridge shall be erected or maintained under the authority of this Act which shall at any time substantially or materially obstruct the free navigation of said streams; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation he is hereby authorized to cause such change or alteration of said bridge or bridges to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge. And in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said streams, caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States for the western district of Louisiana: *Provided*, That nothing in this act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers or to exempt said bridges from the operation of the same. Free navigation. Changes. Litigation. *Proviso.* Existing laws.

SEC. 4. That all railway companies desiring the use of said bridges, or either of them, shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use. Use by other companies.

SEC. 5. That the bridges authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of navigation of said streams as the Secretary of War shall prescribe; and to secure that object the said company or corporation shall submit to the Secretary of War, for his examination and approval, a design and drawings of said bridges, and each of them, and a map of the location, giving, for the space of one-half mile above and one-half mile below the proposed Secretary of War to approve plans, etc.

location, the topography of the banks of the streams, the shore lines at high and low water, the direction and strength of the currents at all stages, and the soundings accurately showing the bed of the stream, the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plan and location of the bridge or bridges are approved by the Secretary of War the bridge or bridges shall not be built; and should any change be made in the plan of said bridges, or either of them, during the progress of construction, such change shall be subject to approval of the Secretary of War. And the said structure shall be changed at the cost and expense of the owners thereof, from time to time, as the Secretary of War may direct, so as to preserve the free and convenient navigation of said streams, and the authority to erect and continue any and all of said bridges shall be subject to revocation by the Secretary of War whenever the public good, in his judgment, so requires.

Changes.

Amendment, etc.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Commencement and completion.

SEC. 7. That this Act shall be null and void if actual construction of the bridge or bridges herein authorized be not commenced within one year and completed within three years from the approval of this Act.

Approved, August 23, 1894.

August 27, 1894.

CHAP. 345.—An Act To authorize the construction of a bridge across the Saint Croix River between Wisconsin and Minnesota.

Osceola, Wis., may bridge Saint Croix River.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the village of Osceola, Polk County, in the State of Wisconsin, a municipal corporation existing under the laws of the State of Wisconsin, is hereby authorized and empowered to erect, establish, and maintain, or authorize the erection, establishment, and maintenance of a foot and wagon bridge across the Saint Croix River at a point suitable to the interests of navigation, from a point in section twenty-seven, township thirty three, range nineteen west, in Polk County, Wisconsin, so as to connect with the opposite shore of said river in the State of Minnesota; that said bridge shall not interfere with the free navigation of said river beyond what is necessary in order to carry into effect the rights and privileges hereby granted, and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river the cause may be tried before the circuit court of the United States in and for any district in which any portion of said bridge or obstruction is located. Said bridge shall be constructed to provide for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for such reasonable rates of toll as may be fixed by the said village of Osceola from time to time and approved by the Secretary of War.

Wagon and foot bridge.

Free navigation.

Litigation.

Toll.

SEC. 2. That the bridge under this act shall be constructed as a pivot drawbridge, with the draw over the main channel of the river at an accessible and navigable point, and with a low-water span of not less than one hundred and ten feet in length in the clear on each side of the central or pivot pier of the draw, measured at right angles to the axis of the channel: *Provided*, That the said draw shall be opened promptly on reasonable signal for the passage of boats, vessels, and other water craft whose construction shall be such as not to admit of their passage under said bridge. **Drawbridge.** *Proviso.* **Opening draw.**

SEC. 3. That any bridge constructed under this act and according to its provisions and conditions shall be a lawful structure, over which may be transmitted the mails, troops, and munitions of war of the United States free of charge; and the United States shall have the right of way for postal-telegraph purposes across said bridge. **Lawful structure.** **Postal telegraph.**

SEC. 4. That the structure herein authorized shall be built and located under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall prescribe, and to secure that object the corporation named shall submit to the Secretary of War, for his examination and approval, a design and drawing of the bridge and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the current, and the soundings, accurately showing the bed of the stream, and shall furnish such other information as shall be required for a full and satisfactory understanding of the subject; and until the said plans and location of the bridge are decided by the Secretary of War to be such as will not materially affect the interest of navigation the bridge shall not be commenced or built; and should any change be made in the plan of said bridge during the progress of construction such change shall be subject to the approval of the Secretary of War; and the said structure shall at all times be so kept and managed as to offer reasonable and proper means for the passage of vessels through or under said structure; and for the safety of vessels passing at night there shall be displayed on said bridge, from the hours of sunset to sunrise, such lights as may be prescribed by the Light-House Board; and the said structure shall be changed or removed, at the cost and expense of the owners thereof, from time to time, as Congress may direct, so as to preserve the free and convenient navigation of said river; and the authority to erect and continue said bridge shall be subject to revocation and modification by law when the public good shall, in the judgment of Congress, so require, without any expense or charge to the United States. **Secretary of War to approve plans, etc.** **Changes.** **Lights.**

SEC. 5. That the right to alter, amend, or repeal this Act is hereby expressly reserved. **Amendment, etc.**

SEC. 6. That this act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date thereof. **Commencement and completion.**

Approved, August 27, 1894.

August 27, 1894.

CHAP. 350.—An Act To authorize the Biloxi and Back Bay Bridge Company to construct and maintain a bridge over that portion of the Bay of Biloxi, in the State of Mississippi, known as Back Bay.

Biloxi and Back Bay Bridge Company may bridge Back Bay.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Biloxi and Back Bay Bridge Company be, and is hereby, authorized and empowered to construct, build, and maintain a bridge over and across that part of Biloxi Bay, in the State of Mississippi, known as Back Bay, so as to connect the town of Biloxi, Mississippi, with the mainland north of it by wagon road and street-car lines.

Wagon, etc., bridge.

Lawful structure and post route.

SEC. 2. That any bridge built under this act shall be a lawful structure, and United States mails and United States troops and munitions of war shall be allowed to pass over it free of charge.

Draw.

SEC. 3. That said bridge shall be constructed with a draw over the main channel of said bay of a sufficient length to afford ample space to admit of the passage through it of such vessels as can navigate said Back Bay, and said draw shall be at right angles to the current of the bay at that point: *Provided*, That said draw shall be opened promptly by said company, upon reasonable signal, for the passage of boats; and said company shall maintain, at its own expense, from sunset to sunrise, such lights or other signals as the Light-House Board shall prescribe.

Proviso.
Opening draw.

Lights, etc.

Free navigation.

SEC. 4. That no bridge shall be erected or maintained under the authority of this act which shall at any time substantially or materially obstruct the free navigation of said Back Bay. And if any bridge erected under such authority shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstruction; all of such changes or alterations shall be made at the expense of the owners of said bridge.

Changes.

Secretary of War to approve plans.

SEC. 5. That construction of the bridge shall not be commenced until a copy of the Coast Survey chart of said Back Bay, with the proposed line of crossing and location of draw marked upon it, and detailed plan showing width of draw and character of proposed construction of bridge and draw, shall have been submitted to and approved by the Secretary of War.

Commencement and completion.

SEC. 6. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date hereof.

Amendment, etc.

SEC. 7. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, August 27, 1894.

CHAP. 351.—An Act To authorize the construction of a bridge across the Osage River, in the State of Missouri.

August 27, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be lawful for the Duluth, Springfield and Gulf Railroad Company, a corporation organized under the laws of the State of Iowa, its successors or assigns, to construct and maintain a bridge across the Osage River at some point on the river in the counties of Morgan or Camden, and State of Missouri, the location to be subject to the approval of the War Department; that said bridge may be constructed for railway, wagon, and postal service, with single or double tracks for railway traffic, and shall be constructed under the conditions and limitations hereinafter specified.

Duluth, Springfield and Gulf Railroad Company may bridge Osage River, Mo.

Railway and wagon bridge.

SEC. 2. That said bridge shall not interfere with the free navigation of said river beyond what may be necessary to carry into effect the rights and privileges herein granted, and in case of any litigation arising under the provisions of this Act, such litigation may be tried and determined by the circuit court of the United States within whose jurisdiction said bridge is located.

Free navigation.

Litigation.

SEC. 3. That the bridge hereby authorized to be constructed must be constructed as a high bridge, with unbroken and continuous spans, having at least one channel span with not less than four hundred feet clear channel way, and all other spans to have a clear channel way of not less than three hundred feet, and all spans shall have a clear head-room of not less than fifty feet above high-water mark, and the piers of said bridge shall be parallel with the current of said river where said bridge may be erected.

High bridge.

SEC. 4. That any bridge constructed under this Act shall be a lawful structure and shall be a post road, over which no higher charge shall be made for the transmission of mails, troops, and munitions of war of the Government of the United States, or for passengers or freight passing over the same than the rate per mile charged for their transportation over the railroad or public highways leading to the said bridge; and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies. The United States shall have also the right of way over said bridge for postal-telegraph purposes.

Lawful structure and post route.

Postal-telegraph.

SEC. 5. That all railway companies desiring to use said bridge shall be entitled to equal rights and privileges in using the same, including the machinery and fixtures thereto belonging, and also the approaches thereto, upon such terms and conditions as shall be prescribed by the Secretary of War upon hearing the allegations and proofs of the parties in interest, in case they shall not be able to agree upon such terms and conditions.

Use by other companies.

Terms.

SEC. 6. That the said railway company, before entering upon the construction of said bridge, shall submit to the Secretary of War plans and drawings of said structure, together with a map of the location thereof for one mile

Secretary of War to approve plans, etc.

above and one mile below said location, giving the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the current of said river at all stages of the water, showing also the bed of the river and the channel, with such other and further information as the Secretary of War may require, which said drawings and other information aforesaid shall be examined by him, and if he shall approve the same he shall so notify the said railway company of such approval, and thereupon said company may proceed to the erection of said bridge. The Secretary of War may direct such alterations in such plans as he may deem necessary to the better protection of navigation, and such alterations shall be made by the said railway company at its expense. The said railway company may at any time make any alterations deemed advisable to be made in said bridge, but must first submit such proposed alterations to the Secretary of War, and his approval shall be first had before they shall be authorized or made.

Alterations.

Aids to navigation.

SEC. 7. That the said bridge herein authorized to be constructed shall be so kept and managed at all times as to afford proper means and ways for the passage of vessels, barges, or rafts under it both by day and night. There shall be displayed on said bridge, from sunset to sunrise, such lights and signals as may be directed by the Light-House Board, and such changes may be made from time to time in the structure of said bridge as the Secretary of War may direct, at the expense of said railway, in order the more effectually to preserve the free navigation of said river, or the said structure shall be altogether removed if, in the judgment of the Secretary of War, the public good may require such removal, and without expense or charge to the United States.

Lights, etc.

Commencement and completion.

SEC. 8. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date of the approval of this Act.

Amendment, etc.

SEC. 9. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, August 27, 1894.

August 27, 1894.

CHAP. 352.—An Act To authorize the construction of a bridge across the Missouri River at De Witt, Carroll County, Missouri, and to establish it as a post road.

Duluth, Springfield and Gulf Railroad Company may bridge Missouri River, De Witt, Mo.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be lawful for the Duluth, Springfield and Gulf Railroad Company, a corporation organized under the laws of the State of Iowa, or its successors or assigns, to construct a bridge across the Missouri River at a point opposite, or as nearly opposite as may be, to the town of De Witt, in the county of Carroll and State of Missouri; that said bridge may be constructed for railway, wagon, and postal

service, with single or double track, for railway traffic, and shall be constructed under the conditions and limitations hereinafter specified. Railway and wagon bridge.

SEC. 2. That said bridge shall not interfere with the free navigation of said river beyond what may be necessary to carry into effect the rights and privileges herein granted, and in case of any litigation arising under the provisions of this Act such litigation may be tried and determined by the circuit court of the United States within whose jurisdiction said bridge is located. Free navigation. Litigation.

SEC. 3. That the bridge hereby authorized to be constructed must be constructed as a high bridge, with unbroken and continuous spans; all spans over the waterway to have a clear channel way of not less than four hundred feet and a clear headroom of not less than fifty-five feet above high-water mark. High bridge.

SEC. 4. That any bridge constructed under this Act shall be a lawful structure, and shall be known as a post road, over which no higher charge shall be made for the transmission of mails, troops, and munitions of war of the Government of the United States or for passenger or freight passing over the same than the rate per mile charged for their transportation over the railroad or public highways leading to the said bridge, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies. The United States shall also have the right of way over said bridge for postal-telegraph purposes. Lawful structure and post route. Postal telegraph.

SEC. 5. That all railway companies desiring to use said bridge shall be entitled to equal rights and privileges in using the same, including the machinery and fixtures thereto belonging, and also the approaches thereto, upon such terms and conditions as shall be prescribed by the Secretary of War upon hearing the allegations and proofs of the parties in interest, in case they shall not be able to agree upon such terms and conditions. Use by other companies. Terms.

SEC. 6. That the said railway company, before entering upon the construction of said bridge, shall submit to the Secretary of War plans and drawings of said structure, together with a map of the location thereof for one mile above and one mile below said location, giving the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the current of said river at all stages of the water, showing also the bed of the river and the channel, with such other and further information as the Secretary of War may require; which said drawings and information aforesaid shall be examined by him, and if he shall approve the same he shall so notify the said railway company of such approval, and thereupon said company may proceed to the erection of said bridge. The Secretary of War may direct such alterations in such plans as he may deem necessary to the better protection of navigation, and such alterations shall be adopted by the said railway company. The said railway company may at any time make any alterations deemed advisable to be made in said bridge, but must first submit such proposed alterations to the Secretary of War, and Secretary of War to approve plans, etc. Alterations.

his approval shall be first had before they shall be authorized or made.

Aids to navigation.

SEC. 7. That the said bridge herein authorized to be constructed shall be so kept and managed, at all times, as to afford proper ways and means for the passage of vessels, barges, or rafts under it, both by day and night. There shall be displayed on said bridge, from sunset to sunrise, such lights and signals as may be directed by the Light-House Board, and such changes may be made, from time to time, in the structure of said bridge as the Secretary of War may direct, at the expense of said railway, in order the more effectually to preserve the free navigation of said river, or the said structure shall be altogether removed, if, in the judgment of the Secretary of War, the public good may require such removal, and without expense or charge to the United States.

Lights, etc.

Commencement and completion.

SEC. 8. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date of the approval of this Act.

Amendment, etc.

SEC. 9. That the right to alter, amend, or repeal this Act is hereby specially reserved.

Approved, August 27, 1894.

RESOLUTIONS.

December 19, 1893.

[No. 6.] Joint Resolution To authorize the Secretary of War to grant permits for the use of the Monument grounds and reservations or public spaces in the City of Washington, and for other purposes.

Knights of Pythias encampment.

Permit to use Monument grounds and reservations, D. C., in August, 1894.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War is hereby authorized to grant permits to the Executive Committee, Knights of Pythias, for the use of the Monument grounds for temporary camp purposes, and the reservations or public spaces along the line of Pennsylvania Avenue for the erection of stands with seats thereon on the occasion of the Pythian Conclave and Encampment to be held in the City of Washington in August, eighteen hundred and ninety-four, if, in his opinion, such use will inflict no serious or permanent injury upon such grounds, reservations or public spaces; and the District Commissioners are hereby authorized to designate such streets, avenues and sidewalks in the District as they may deem necessary and proper for the purposes of the occasion.

Approved, December 19, 1893.

[No. 23.] Joint Resolution Directing the Secretary of War to cause an examination to be made to determine if there is probability and danger of the Mississippi River cutting through the space dividing such river from the Saint Francis River in the vicinity of Walnut Bend, Arkansas.

May 4, 1894.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he is hereby, authorized and directed to cause an examination to be made to determine if there is probability and danger of the Mississippi River cutting through the space dividing such river from the Saint Francis River in the vicinity of Walnut Bend, Arkansas, some twenty miles above the mouth of the Saint Francis River, and if such danger exists, to cause to be made a survey and estimate of the amount necessary to prevent damage to the navigation of the Saint Francis River.

Mississippi River.
Examination near Walnut Bend, Ark., as to danger to St. Francis River.

Approved, May 4, 1894.

[No. 33.] Joint Resolution Directing the Secretary of War to appoint a commission of engineers to examine and report upon the cost of deepening the harbors of Superior and Duluth and their entrances to a uniform depth of twenty feet.

June 29, 1894.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he is hereby, directed to appoint a commission, to consist of three engineers, to examine the harbors of Superior and Duluth and the entrances thereto, with a view of ascertaining the cost of deepening said harbors and entrances to a uniform depth of twenty feet, and to report their conclusions to the Secretary of War without delay, to be by him transmitted to Congress.

Harbors of Duluth and Superior.
Commission to examine cost of deepening entrance.

Approved, June 29, 1894.

PRIVATE ACTS.

CHAP. 115.—An Act To provide for the adjustment and payment of the claim of Thomas Rhys Smith for work done and materials furnished for the breakwater at Bar Harbor, Maine.

June 23, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he is hereby, authorized and directed to examine and adjust the claim of Thomas Rhys Smith against the Government of the United States for work done and materials furnished for the breakwater at Bar Harbor, Maine, under a contract between said Thomas Rhys Smith and the United States, and determine what amount of work was done and materials furnished thereunder, the amount paid on account thereof, and the balance remaining unpaid, which balance he shall certify to the proper accounting officers for payment in the manner prescribed by law; and for the payment of said claim the sum

Thomas Rhys Smith.
Claim for work, etc., Bar Harbor, Me., to be adjusted.
Payment.

of six thousand three hundred and ninety-one dollars and twelve cents, or so much thereof as may be necessary, is hereby appropriated out of any money in the Treasury not otherwise appropriated: *Provided*, That before making any payment the Secretary of War shall exact from said Thomas Rhys Smith a bond in the penal sum of ten thousand dollars, with sufficient sureties, to be approved by him, conditioned to indemnify the United States against any lawful claim of any other party or parties.

Proviso.

Indemnity bond.

Approved, June 23, 1894.

August 8, 1894.

CHAP. 240.—An Act To provide for the adjustment and payment of the claim of the American Transportation Company for dredging done at Fairport Harbor, in the State of Ohio.

American Transportation Company.

Payment of claim for dredging Fairport Harbor, Ohio.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he is hereby, authorized and directed to examine and adjust the claim of the American Transportation Company against the Government of the United States for dredging done at Fairport Harbor, in the State of Ohio, under a contract between said American Transportation Company and the United States, and determine what amount of dredging was done thereunder, the amount paid on account thereof, and the balance remaining unpaid, which balance he shall certify to the proper accounting officers for payment in the manner prescribed by law; and for the payment of said claim the sum of five thousand four hundred and thirty-four dollars and eighteen cents, or so much thereof as may be necessary, is hereby appropriated, out of any money in the Treasury not otherwise appropriated.

Approved, August 8, 1894.

August 17, 1894.

CHAP. 298.—An Act To authorize the appointment of James William Abert to the retired list of the Army.

James William Abert.

May be appointed major, Army retired list.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the President be, and he is hereby, authorized, by and with the advice and consent of the Senate, to appoint James William Abert to the Army of the United States, and to place said Abert on the retired list thereof with the rank of major of engineers.

Received by the President, August 6, 1894.

[NOTE BY THE DEPARTMENT OF STATE.—The foregoing act having been presented to the President of the United States for his approval, and not having been returned by him to the house of Congress in which it originated within the time prescribed by the Constitution of the United States, has become a law without his approval.]

CHAP. 324.—An Act For the relief of B. D. Greene. August 23, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Treasury is directed to pay, out of any money in the Treasury not otherwise appropriated, to B. D. Greene, bondsman of George E. Ward, who shall file the proper vouchers for money advanced or labor and materials furnished in and about the work of improvement on the Rappahannock River during the year eighteen hundred and eighty-nine, the sum of one thousand nine hundred and sixteen dollars and ninety-seven cents, being the amount due George E. Ward by the Government, which said sum shall be paid to the said B. D. Greene.

B. B. Greene. Payment to, as bondsman of George E. Ward.

Approved, August 23, 1894.

CHAP. 354.—An Act Directing the issue of a duplicate of a lost check drawn by Captain W. H. Bixby, Engineers United States Army, at Newport, Rhode Island, in favor of Messrs. Hughes Brothers and Bangs. August 27, 1894.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Captain W. H. Bixby, Engineers United States Army, be, and is hereby, authorized and instructed to issue a duplicate of an original check under such regulations in regard to its issue and payment as have been prescribed by the Secretary of the Treasury for the issue of duplicate checks under the provisions of section thirty-six hundred and forty-six, Revised Statutes of the United States. Said duplicate check to take the place of an original check issued by said W. H. Bixby on September twenty-fifth, eighteen hundred and ninety-three, upon the subtreasury at New York, in favor of Hughes Brothers and Bangs, for the sum of five thousand and eleven dollars and ninety-three cents, and numbered two hundred and fifty-nine thousand and one, being for services in August, eighteen hundred and ninety-three, under their contract with the United States for work at Point Judith, Rhode Island, which check is alleged to have been lost in its transmission through the United States mail.

Hughes Brothers and Bangs. Duplicate check to issue to.

R. S., sec. 3646, p. 717.

Approved, August 27, 1894.

INDEX.

[The references in Roman are to part (or volume), and those in Arabic to page.]

A.

INDEX.

[The references in Roman are to part (or volume), and those in Arabic to page.]

A.

B.

C.

H.

I.

J.

K.

L.

M.

N.

O.

P.

S.